GEOPHYSICAL FEASIBILITY SURVEY

KOPPERS SOUTH CAVALCADE SITE

HOUSTON, TEXAS

File

FOR

KOPPERS COMPANY, INC.

PITTSBURGH, PA

PREPARED BY

MCBRIDE-RATCLIFF AND ASSOCIATES, INC.

HOUSTON, TEXAS

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McBride-Ratcliff and Associates, Inc.

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GEOPHYSICAL FEASIBILITY SURVEY
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FOR

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PITTSBURGH, PA

PREPARED BY

MCBRIDE-RATCLIFF AND ASSOCIATES, INC.

HOUSTON, TEXAS

McBride-Ratcliff and Associates, Inc.

McBride-Ratcliff
and Associates, Inc.
Geotechnical Consultants
7220 Langtry Houston, Texas 77040 713-460-3766

December 18, 1985

Koppers Company, Inc.
1940 Koppers Building
436 Seventh Avenue
Pittsburgh, Pennsylvania 15219

ATTENTION: Dr. James R. Campbell
Previously Owned Properties

SUBJECT: Geophysical Feasibility Survey
Koppers South Cavalcade Site
Houston, Texas
MRA File No. 85-317

Presented here is the final report of our geophysical feasibility survey at the Koppers South Cavalcade Site in Houston, Texas. This report is submitted in response to Subtask 2C of the EPA South Cavalcade Street Work Plan and was conducted in general accordance with Section 9.0 of the Koppers Field Sampling and Analytical Plan. A preliminary geophysical feasibility survey report was submitted on November 4, 1985 and included an evaluation of surface resistivity and electromagnetic methods.

This geophysical survey includes an evaluation of the feasibility of surface resistivity, electromagnetic, and ground-penetrating radar geophysical methods for a detailed site survey. The electromagnetic profiling method proved to be more sensitive of the geophysical methods evaluated.

We appreciate this opportunity to be of service. Please contact us if you have any questions.

Sincerely,

McBRIDE-RATCLIFF AND ASSOCIATES, INC.

Paul C. Moore
Project Geologist

J. L. Ireland, C.P.G.
Vice President

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Copies Submitted - 10

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SUMMARY

A geophysical feasibility survey was performed in the vicinity of Area 1 at the Koppers South Cavalcade site in Houston, Texas. The objective of the feasibility survey was to evaluate if geophysical methods were applicable for a detailed site survey. Two additional paved test sites were also evaluated.

The principal findings and conclusions of the geophysical feasibility survey are summarized as follows:

1. The surface resistivity sounding method was generally less sensitive to subsurface anomalies at a grid spacing of 50 ft.

2. The electromagnetic (EM) profiling method was responsive subsurface anomalies. The EM profiling method appears to be feasible in unpaved areas and areas paved with asphalt.

3. The ground-penetrating radar (GPR) profiling method did not achieve a significant penetration depth at the test sites due to the highly conductive nature of the upper clay soils. The GPR profiling method was generally responsive to surficial anomalies in unpaved areas. The GPR method did not disclose a potential subsurface anomaly at an asphalt paved area.

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INTRODUCTION

The geophysical feasibility survey was conducted at the Koppers South Cavalcade Site in Houston, Texas. The test sites evaluated included areas covered with grass, asphalt paving, and steel reinforced concrete.

The objective of the geophysical feasibility survey was to evaluate which geophysical method or combination of geophysical methods are potentially applicable for a detailed site survey.

FEASIBILITY SURVEY

Test Locations

The surface resistivity and electromagnetic geophysical feasibility survey was performed on October 17 and 21, 1985 by McBride-Ratcliff and Associates, Inc. The ground-penetrating radar (GPR) geophysical feasibility survey was performed on November 20, 1985 by Detection Sciences, Inc. The South Cavalcade Site location is shown on Figure 1.

Three test sites were used in this investigation as shown on Figure 2. Test Site 1 was located in the vicinity of Area 1 as described in Section 9.1 of the Koppers Field Sampling and Analytical Plan. The test site measured 150 ft by 150 ft and was located to include Soil Boring CAV-SL-03 and Monitoring Well CAV-OW-06 from the previous contaminant survey by Camp, Dresser, and McKee.

Test Site 2 was located in the paved asphalt parking lot of Transcon Truck Lines, north of Test Site 1. This test site measured 90 ft by 40 ft. This location was chosen to evaluate the feasibility of using geophysical techniques in areas paved with asphalt.

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Test Site 3 was located at the entrance to Transcon Truck Lines on Cavalcade Street to evaluate if geophysical methods could be used in an area of concrete paving. This test site measured 80 ft by 80 ft. All geophysical field work was conducted under the surveillance of representatives from Camp, Dresser, and McKee.

Test Procedures

Resistivity Soundings. The earth resistivity sounding method was performed first at the test site. This geophysical method requires physical soil contact; thus, the resistivity soundings were limited to Test Site 1. The resistivity soundings were conducted in accordance with the guidelines set forth by the Texas Department of Health, Division of Solid Waste Management: Technical Guide No. 1, dated March 24, 1980. These guidelines are generally accepted by the profession as state-of-the-practice for engineering geophysics. All readings for this test were obtained using a Bison Instruments Model 2350B Earth Resistivity Meter.

The location of the resistivity sounding stations are shown on Figure 3. The resistivity sounding stations were located at a 50-ft grid spacing in accordance with Section 9.1 of the Koppers Field Sampling and Analytical Plan. The Lee Modification of the Wenner Electrode Configuration was used for the resistivity sounding survey. The Lee Modification was chosen since it introduces a fifth electrode into the center of the array to distinguish between horizontal and vertical variations of the subsurface. This electrode configuration is illustrated on Figure 4.

The resistivity soundings were performed by incrementally increasing the electrode spacing ("A" spacing) by 3-ft

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intervals, with the fifth electrode remaining stationary in the center of the array. The electrode spacing is proportional to the depth of subsurface penetration. For each increase in the "A" spacing, three resistivity measurements were taken: the normal Wenner, the left Lee and the right Leė. The left and right Lee curves were used to evaluate horizontal variations in the subsurface. The incremental increase provided an estimation of average apparent layer resistivity values for depths ranging from 3 ft to 21 ft. The "A" spacing range for the soundings was based on the approximate depth of the upper sand layer identified in previous site investigations. All electrode lines were oriented in a north-south direction. Resistivity sounding data are included for reference in Appendix B.

Electromagnetic Profiling. The electromagnetic profiling method was performed at all three test site locations. The electromagnetic profiling was conducted under the guidelines set forth in Section 4.0 of the Geonics Limited: EM 31 Operating Manual, revised June, 1984. All readings for this method were obtained using a Geonics Limited Model EM31-D Non-Contacting Terrain Conductivity Meter.

The intercoil spacing of the EM31-D unit is fixed at approximately 12 ft. This spacing yields a penetration depth of approximately 19.7 ft. Readings were obtained at station intervals of 30 ft with a 20 ft spacing between station traverses in accordance with Section 9.1 of the Koppers Field Sampling and Analytical Plan. The location of the profiling stations are shown on Figures 3, 5 and 6. Two sets of readings were obtained at each station, one with the coils oriented north-south, the other with the coils oriented east-west. This procedure yields an average value to compensate for lateral variations in apparent conductivity at each station. Electromagnetic profiling data are included for reference in Appendix C.

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Ground-Penetrating Radar. The ground-penetrating radar (GPR) profiling method was performed at all three test site locations by Detection Sciences, Inc. All readings for this method were obtained using a custom-modified 120 MHz radar antenna in conjunction with a GSSI SIR System - 8 radar system which was also custom-modified by Detection Sciences, Inc., to increase depth penetration. Further details of the GPR feasibility survey are presented in Appendix A.

DATA EVALUATION

Resistivity Soundings

The resistivity sounding data are presented in Appendix B. The data were interpreted by using the following empirical methods:

* Resistivity Contouring.
* Depth - Profile Resistivity Curve.
* The Barnes Layer Method.
* The Moores Cumulative Curve.

Resistivity Contouring. The resistivity contouring method was used to evaluate areas of abnormally high to abnormally low resistivity, which could possibly correlate to subsurface anomalies. A single reading for a constant electrode spacing was taken from each station. The apparent resistivity readings for that electrode spacing were then plotted to their corresponding stations located on a map. Contours of equal apparent resistivity were drawn in relation to the stations. The contour map resulting from this procedure is then used to identify areas of anomalous high or low resistivity.

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Depth-Profile Method. The depth-profile method was used to evaluate the contacts of the upper sand layer. Lateral variations in this layer and in overlying layers may be detected by using the Lee electrode configuration. The apparent resistivity values for a single station were plotted against the corresponding electrode spacings. The resulting curves were then interpreted to evaluate the approximate depth to the upper sand layer. Figure 7 is an example of a depth-profile curve.

Barnes Layer Method. The Barnes Layer Method was also used to evaluate stratigraphic contacts. The Barnes Layer Method assumes that the soil behaves as a set of horizontal layers in which the thickness of each layer is equal to an increment in electrode spacing. This method enables a specific apparent resistivity to be assigned to the material at depth. This method is useful in estimating soil type.

The conversion of electrical resistivity at depth directly to soil type by the Barnes Layer Method assumes that the meter reading reflects the average resistance of a layer equal in thickness to the electrode separation. A direct resistivity value may be assigned to each soil layer by using the Barnes Formula modified for the Bison Instruments Model 2350B Earth Resistivity Meter.

The following tabulation shows typical ranges of general resistivity values for various soil types:

Type of Soil	Resistivity (ohm/cm)
Clays (CH)	200 - 2,000
Silty and Sandy Clays (CL)	1,000 - 3,000
Clayey and silty sands (SC, SM)	3,000 - 75,000
Gravels (GP, GW)	30,000 - 100,000

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The resulting apparent resistivity values are plotted against electrode spacing to produce a graph used for the interpretation. An example of this graph is shown on Figure 8.

Moores Cumulative Method. The Moores Cumulative Curve is used to evaluate the depth of changes in subsoil materials. The Moores Method multiplies the electrode spacing (depth) by the meter value (ohm). The cumulative values are plotted against the increasing depth. The resulting graph will reveal changes in the slopes of the lines connecting the points which corresponds to soil strata depths. An example of this curve is also shown on Figure 8.

Electromagnetic Profiling

The conductivity profiling data were interpreted using empirical profiling and contouring methods. The conductivity profiling and contouring methods were used to evaluate areas of abnormally high to abnormally low apparent conductivity, which could possibly correlate with subsurface anomalies. Two readings were taken at each station at a constant intercoil spacing. The apparent conductivity readings were then plotted against their corresponding stations. The resulting graph, as shown on Figure 9, was used for interpretation.

The same readings were then plotted to their corresponding stations located on a map and contours of equal apparent conductivity were drawn in relation to the stations. The resulting contour map was then used to evaluate subsurface anomalies.

Ground-Penetrating Radar Profiling

Details on GPR data interpretation are presented in Appendix A.

TEST RESULTS

Test Site 1 Evaluation

Conductivity, surface resistivity, and ground-penetrating radar techniques were tested to evaluate relative responses between background conditions and previously documented subsurface anomalies at Area 1.

The conductivity profiling survey disclosed values ranging from a negative off-scale to 360 mmho/m. The average background range of soil conductivity values appears to vary from about 40 to 60 mmho/m.

Figures 10 through 12 present apparent conductivity contour maps based on readings taken in a north-south and east-west orientation, and an average of these two readings. The contoured areas of apparent conductivity values greater than about 60 mmho/m and less than about 40 mmho/m indicate possible subsurface anomalies.

Data from the resistivity soundings was used to develop resistivity contour maps. Figures 13 through 15 are the resistivity contour maps based on the apparent resistivity and were prepared using the resistivity contouring method.

The resistivity sounding data were generally less sensitive to subsurface anomalies located at Test Site 1. Figure 13 to 15 typically do not exhibit similar contouring patterns as the electromagnetic profiling data (Figures 10 to 12).

The Test Site 1 evaluation test results using the ground-penetrating radar geophysical method is presented in Appendix A.

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Test Site 2 Evaluation

Electromagnetics and ground-penetrating radar were tested in the asphalt paved area at Test Site 2 to evaluate potential damping and interferences caused by asphalt paving. Figures 16 through 18 present apparent conductivity contour maps of the paved asphalt test area. The measured conductivity values ranged from 51 mmho/m to 175 mmho/m.

Our interpretation of these apparent conductivity values are the same as for the Test Site 1 interpretation. Conductivity values greater than about 60 mmho/m and less than about 40 mmho/m may indicate areas of subsurface anomalies. These areas were disclosed in the northwestern corner of the paved asphalt test area.

Ground-penetrating radar evaluations for Test Site 2 are presented in Appendix A.

Test Site 3 Evaluation

Conductivity and ground-penetrating radar techniques were also tested in the concrete paved area at Test Site 3 to evaluate potential damping and interferences caused by reinforced concrete paving. Negative off-scale values were generated for the most part in the concrete paved area. Only when the coils were aligned parallel with expansion joints or large cracks in the concrete could readings be obtained. The high conductivity values generated at the expansion joints and cracks, as compared to the values of the test plots, were not representative of the subsurface underlying the concrete paving, and that these values should be disregarded.

Test Site 3 ground-penetrating radar evaluations are presented in Appendix A.

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CONCLUSIONS

Evaluation of apparent resistivity sounding data indicates a generally lower sensitivity to subsurface anomalies because of the 50-ft grid spacing. This procedure is, however, more responsive to vertical variations in lithology. Resistivity profiling methods may be more appropriate to evaluate the locations and lateral extent of subsurface anomalies.

The electromagnetic profiling data resulted in a wide range of conductivity values for all of the test sites. Those areas that exhibited conductivity values greater than 60 mmho/m or less than 40 mmho/m were interpreted as potential subsurface anomalies. The conductivity method appears to respond to subsurface anomalies in areas paved with asphalt. Areas paved with steel reinforced concrete disclosed sufficient damping resulting in generally low sensitivities.

The ground-penetrating radar profiling method detected electromagnetic responses in the subsurface limited to a depth of approximately 7 feet. The ground-penetrating radar method appears to have a limited penetration depth at the site due to the high electrical conductivity of the upper clayey stratum which is highly attenuative of the radar pulse. The ground-penetrating radar appears to have a generally low sensitivity to electromagnetic responses in the shallow subsurface in areas paved with asphalt. The areas paved with steel reinforced concrete exhibited sufficient damping resulting in generally low sensitivities.

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RECOMMENDATIONS

We recommend the electromagnetic profiling method be used to conduct the site geophysical survey. The advantages of using EM profiling are outlined as follows:

1. Greater depth penetration than GPR which is limited to the upper clayey soils.

2. Responsive to potential subsurface anomaly in an asphalt paved area not detected by GPR.

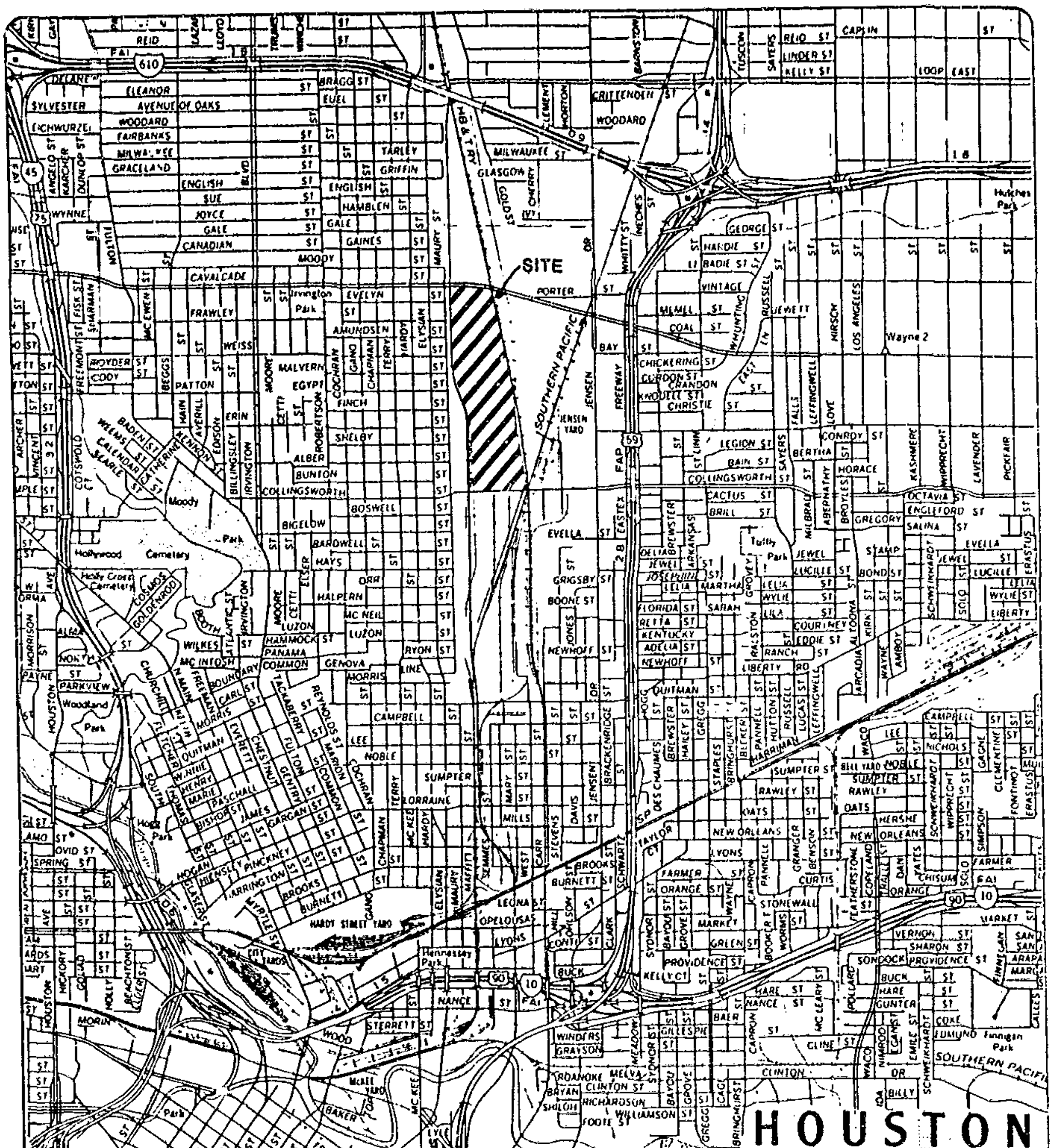
3. Can be used in asphalt paved areas that are not generally feasible for surface resistivity methods.

4. Permits real time measurements for field interpretation for flexibility in changing grid spacing to more accurately delineate anomalous areas.

The preliminary geophysical assessment of this site was based upon our professional evaluation of the geophysical data gathered and our experience with the geophysical properties of the geology in the area. The geophysical evaluation rendered in this report meets the standards of care of our profession. No other warranty or representation, either expressed or implied, is included or intended.

FIGURES

002119



VICINITY MAP

KOPPERS SOUTH CAVALCADE SITE

HOUSTON, TEXAS

N

SCALE-MI.

0 0.25 0.5 1

FIGURE 1
FILE: 85-317

McBride-Ratcliff and Associates, Inc.

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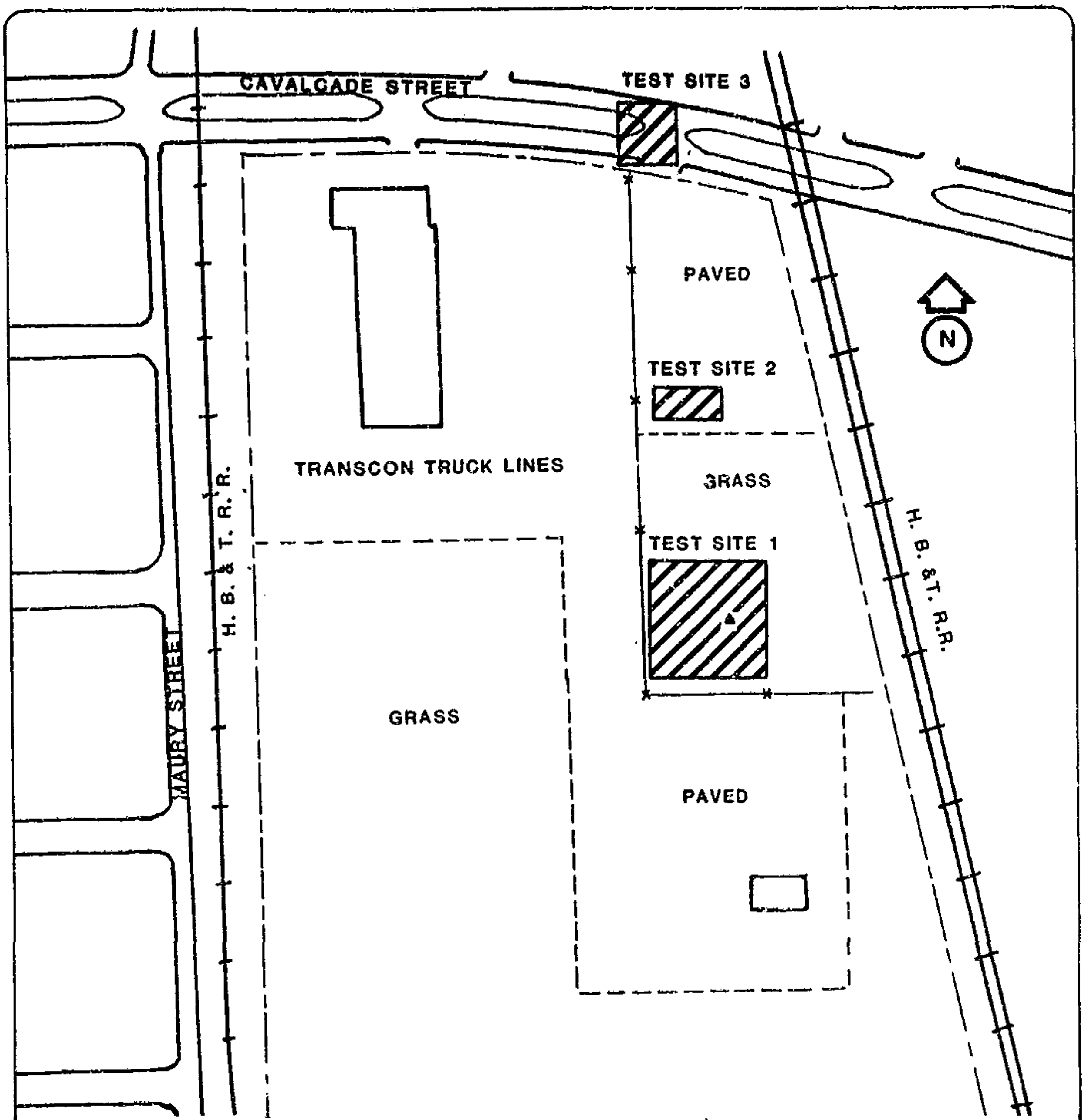


TEST PLOT LOCATION MAP

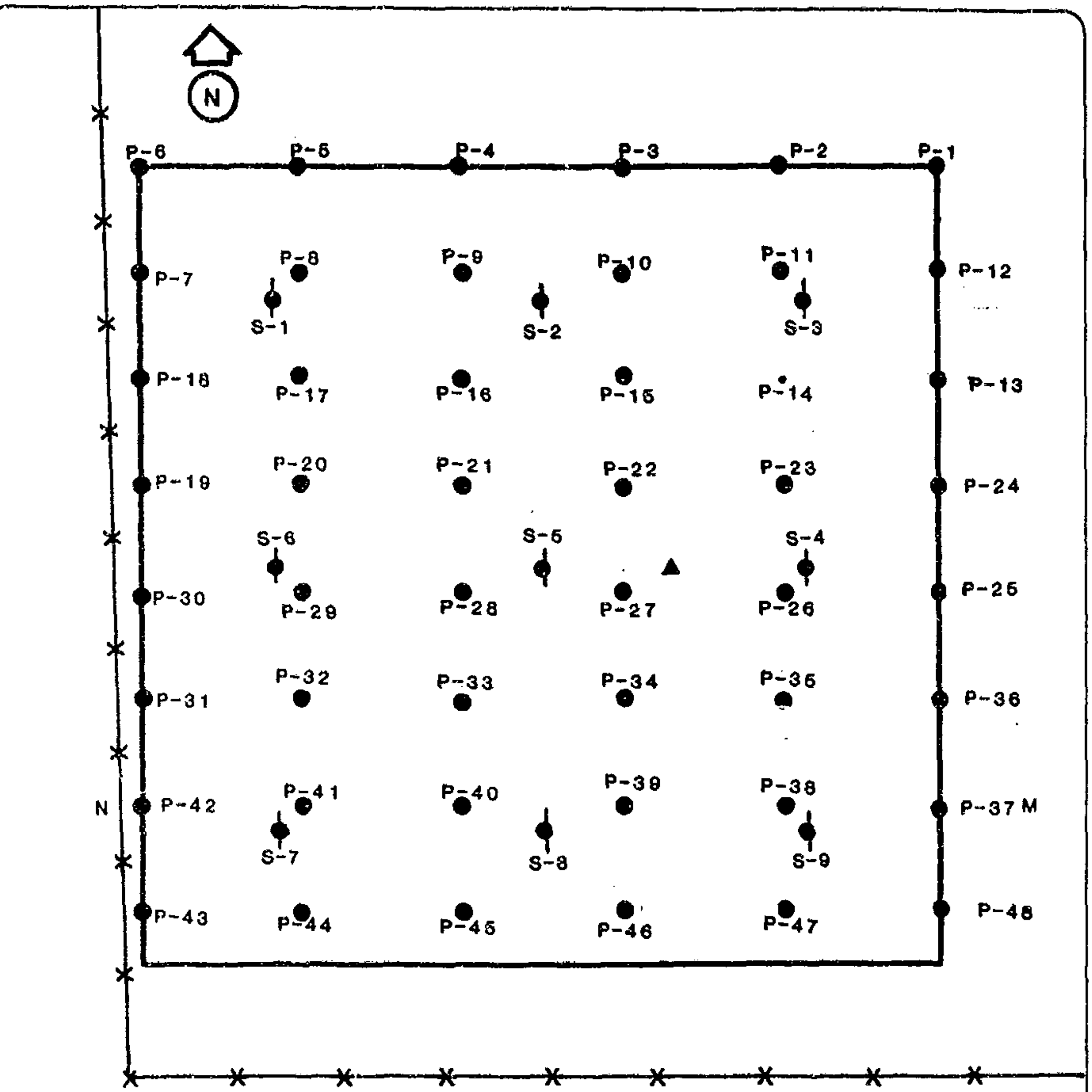
SCALE-FT.
0 100 200

LEGEND
▲ WELL CAV-OW-06
TEST PLOT

FIGURE 2
FILE: 85-317

McBride-Ratcliff and Associates, Inc.

002121



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TEST SITE 1
STATION LOCATIONS

LEGEND

RESISTIVITY SOUNDING STATION

ELECTROMAGNETIC PROFILING STATION

WELL CAV-OW-06

FENCE

N-M TRAVERSE LINE N-M

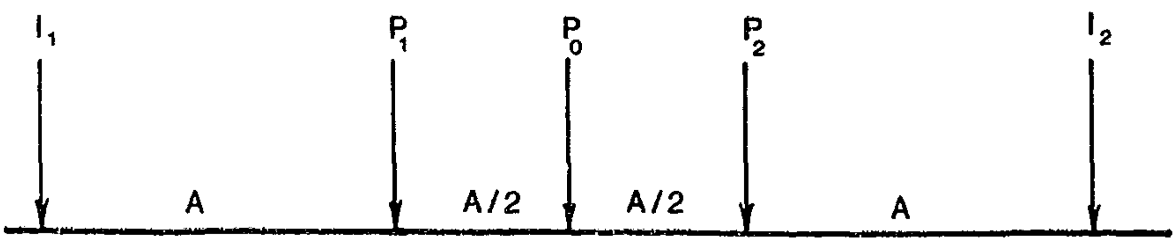
SCALE-FT.

0 15 30

FIGURE 3
FILE: 85-317

McBride-Ratcliff and Associates, Inc.

LEE MODIFICATION OF WENNER



LEGEND

A ELECTRODE SPACING

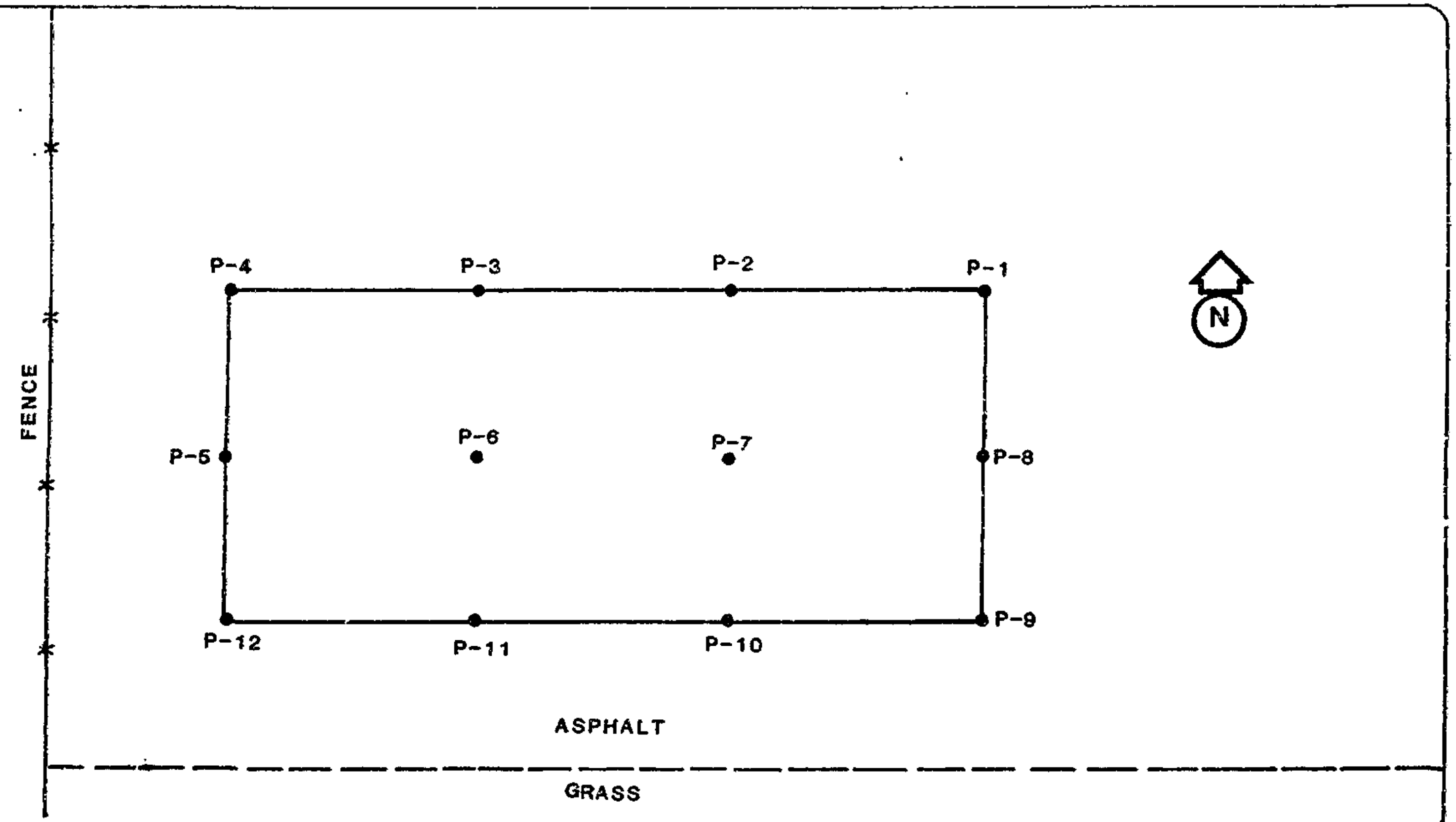
I CURRENT ELECTRODE

P POTENTIAL ELECTRODE

FIGURE 4
FILE: 85-317

McBride-Ratcliff and Associates, Inc.

002123



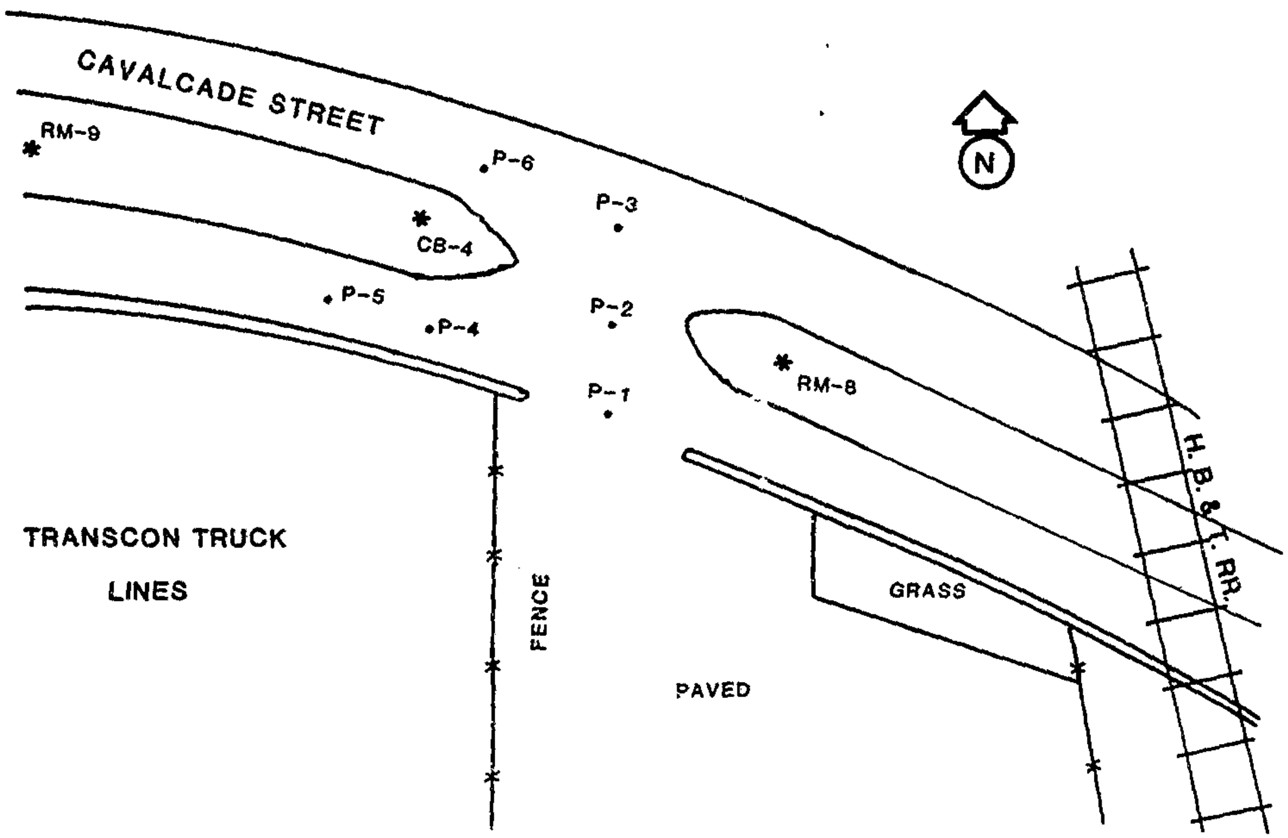
TEST SITE 2 STATION LOCATIONS

SCALE-FT.
0 10 20

FIGURE 5
FILE: 85-317

McBride-Ratcliff and Associates, Inc.

002124



TEST SITE 3 STATION LOCATIONS

FIGURE 6
FILE: 85-317

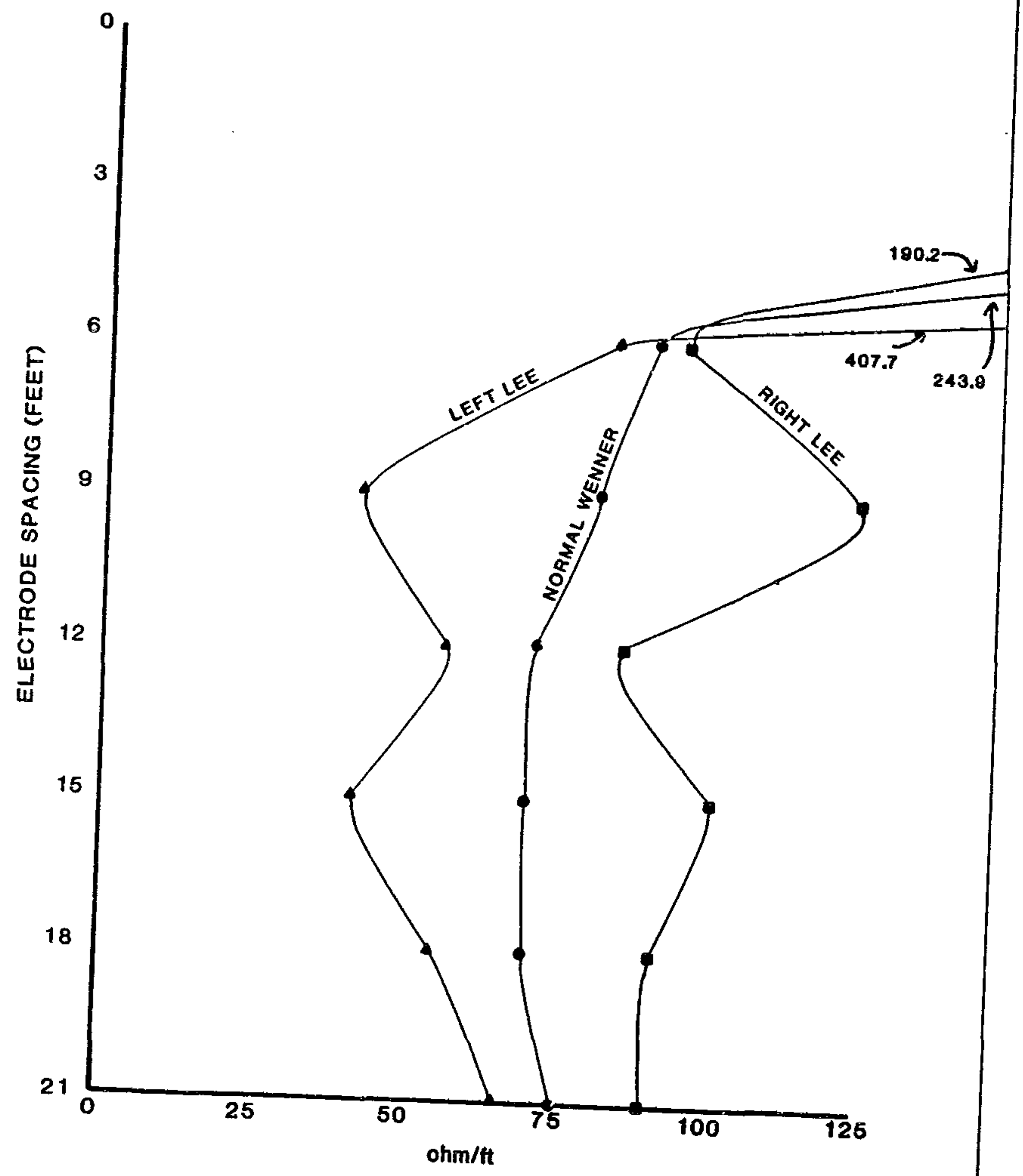
LEGEND

✱ PREVIOUS BORING

SCALE-FT.
0 25 50

McBride-Ratcliff and Associates, Inc.

002125



DEPTH-PROFILE CURVE OF THE WENNER AND LEE ELECTRODE CONFIGURATIONS

TEST SITE 1

SOUNDING NO.: S-8

FIGURE 7
FILE: 85-317

McBride-Ratcliff and Associates, Inc.

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RESISTIVITY SOUNDING
TEST SITE 1
JOB NO.: 85-317
SOUNDING NO.: S-6

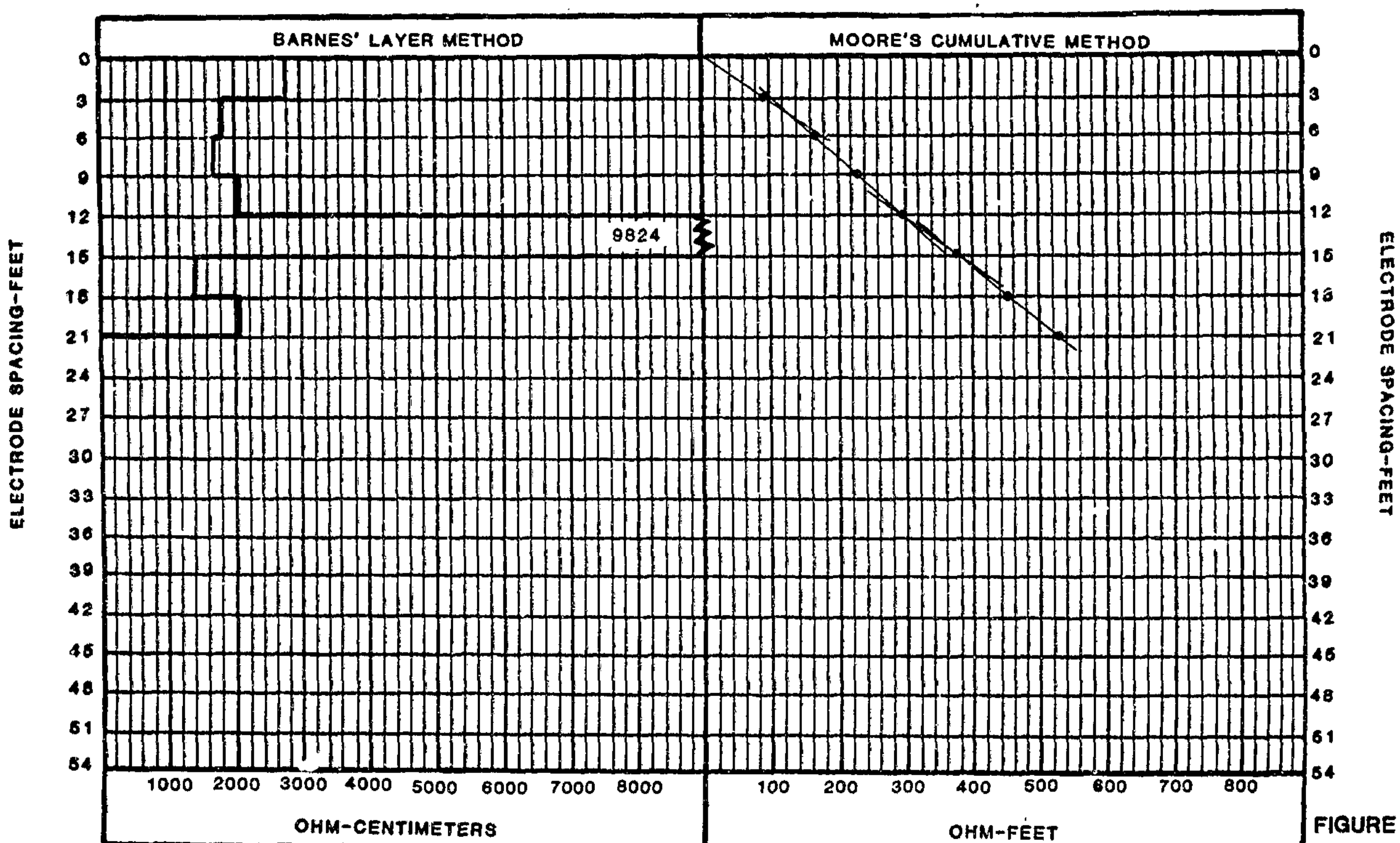
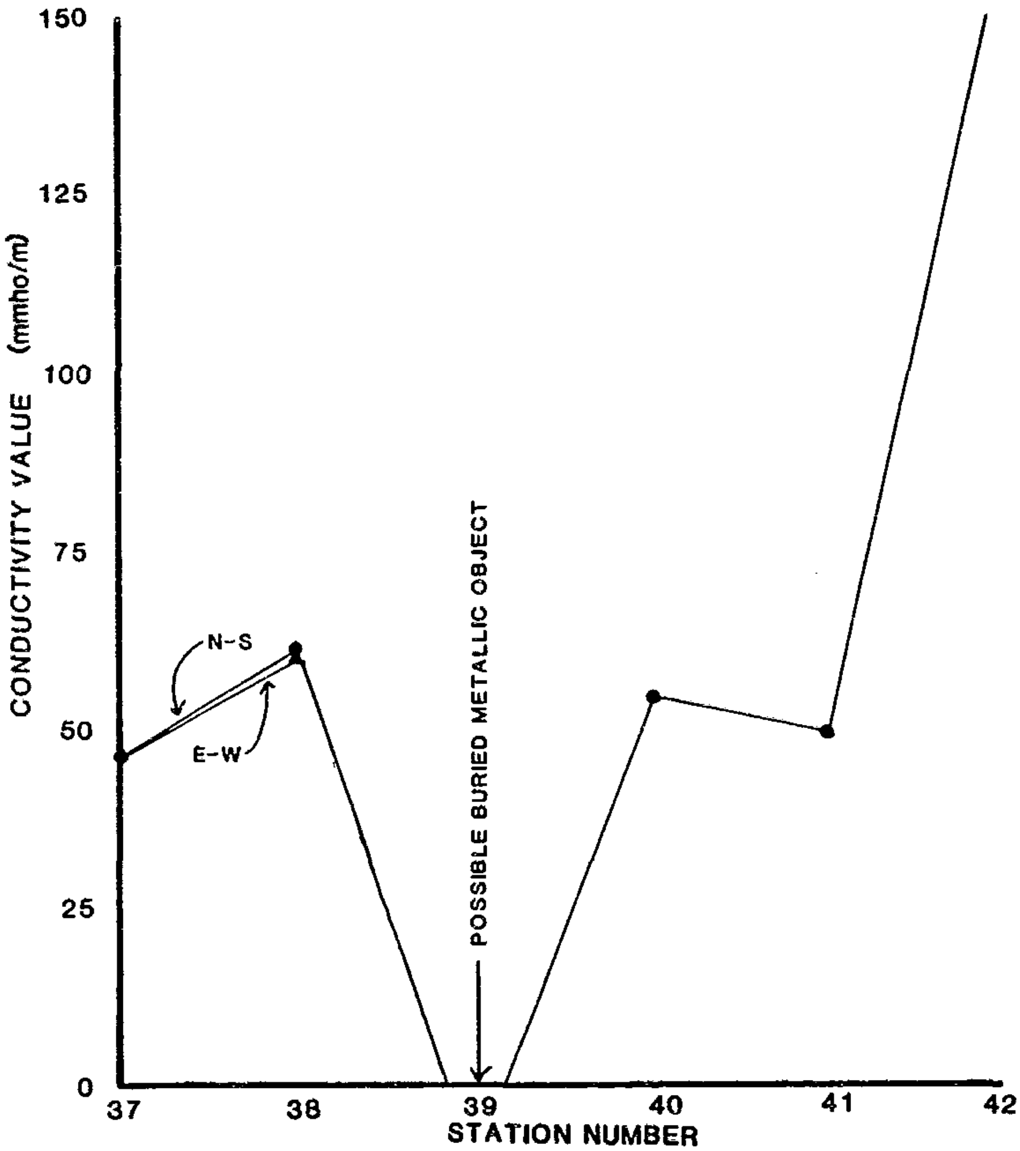


FIGURE 8

McBride-Ratcliff and Associates, Inc.



CONDUCTIVITY PROFILE M-N
TEST SITE 1

FIGURE 9
FILE: 85-317

McBride-Ratcliff and Associates, Inc.

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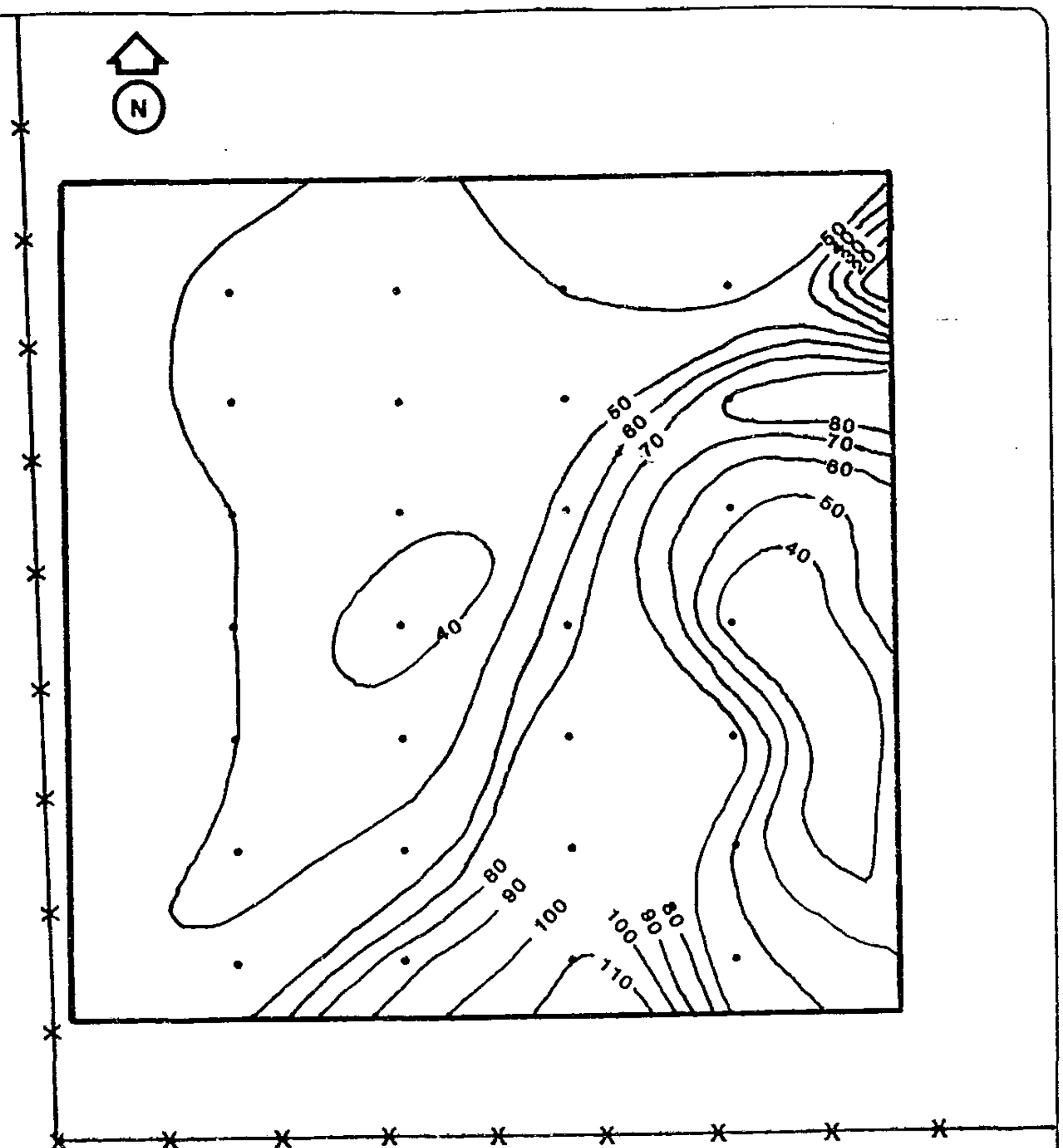

E-W CONDUCTIVITY CONTOUR MAP
TEST SITE 1

10 mmho/m CONTOUR INTERVAL

LEGEND

• PROFILING STATION

SCALE-FT.

0 15 30

002129

FIGURE 10
FILE: 85-317

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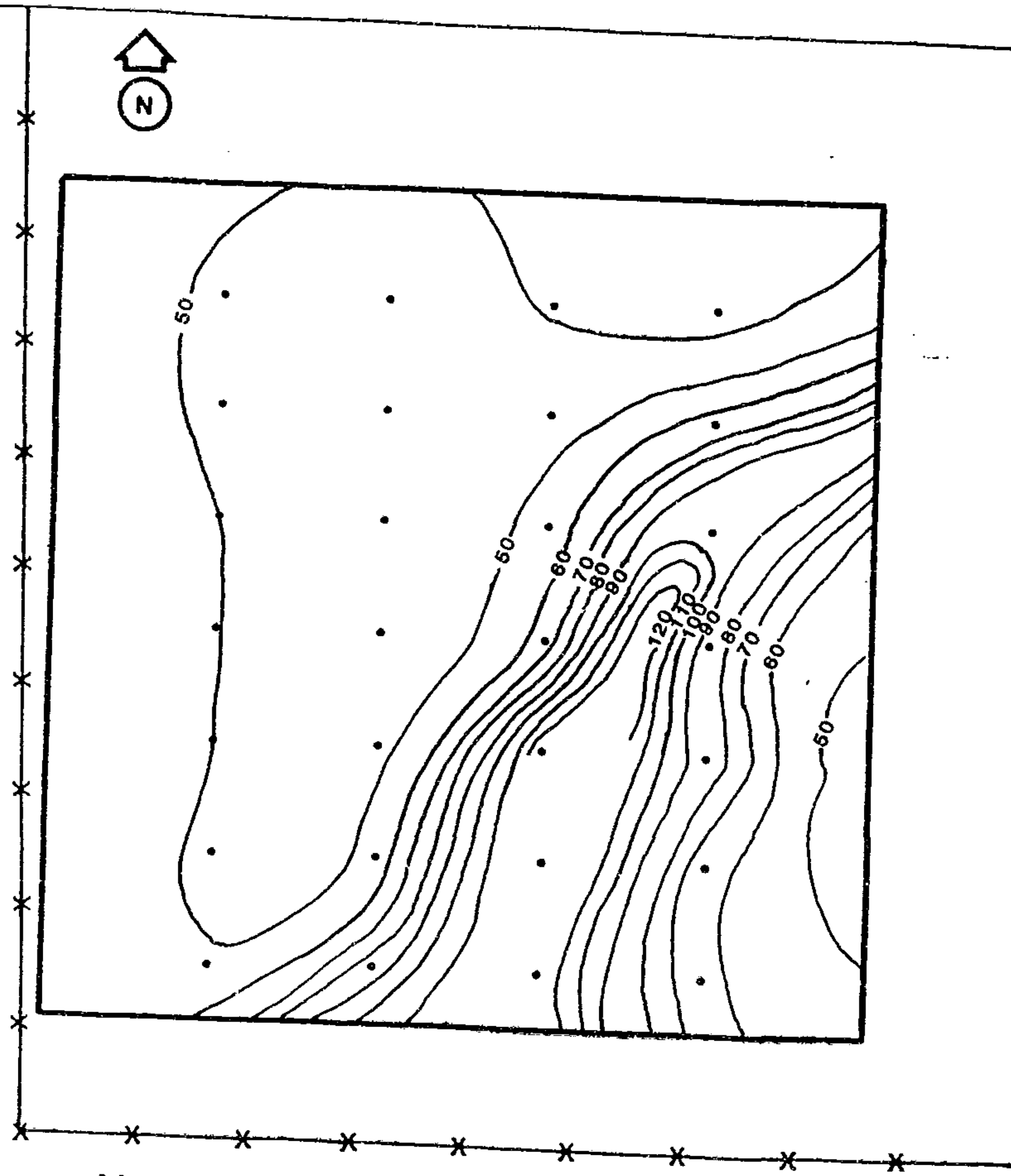

N-S CONDUCTIVITY CONTOUR MAP
TEST SITE 1

10 mmho/m CONTOUR INTERVAL

LEGEND

• PROFILING STATION

SCALE-FT.
0 15 30

FIGURE 11
FILE: 85-317

McBride-Ratcliff and Associates, Inc.

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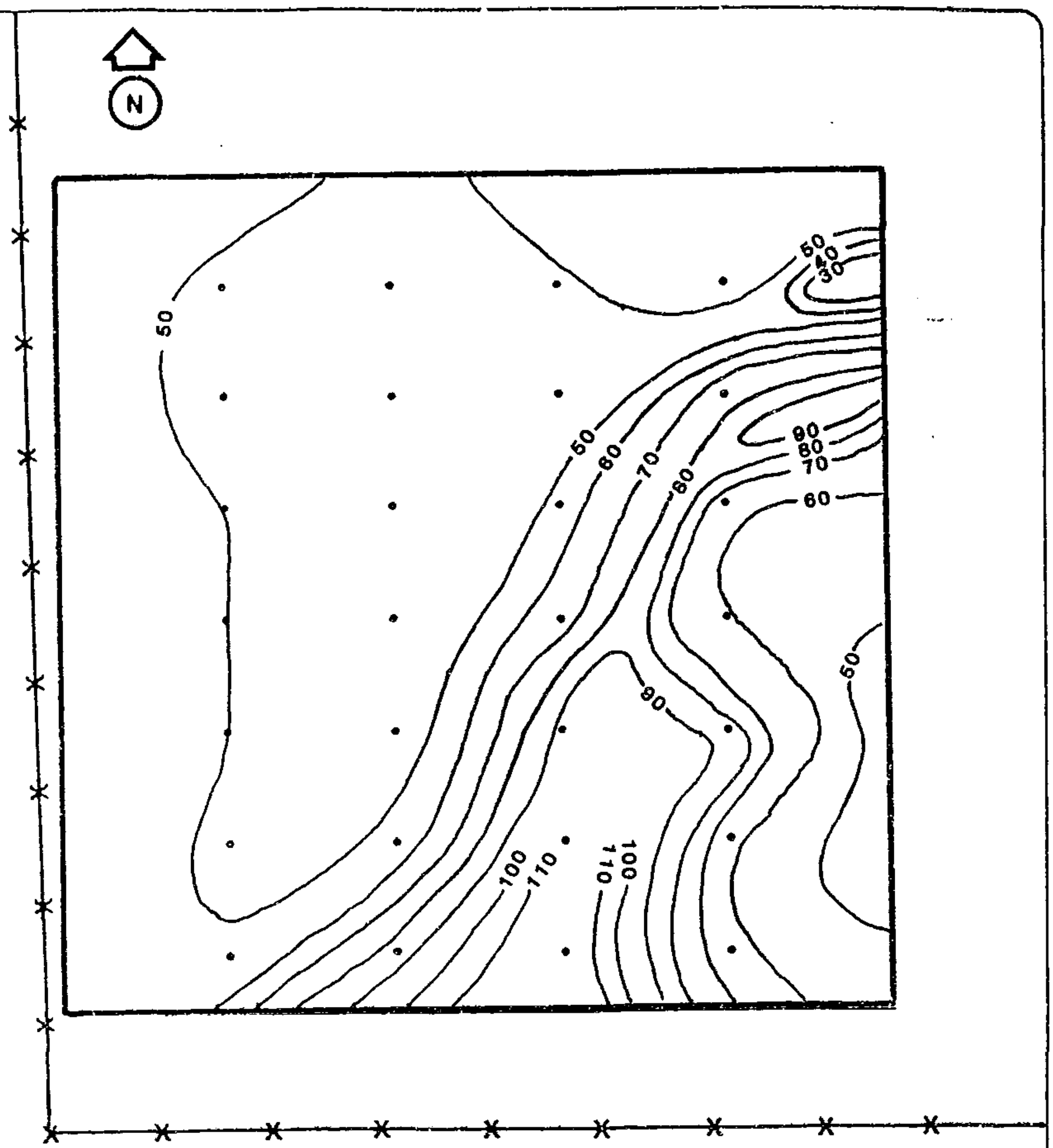

AVERAGE VALUE CONDUCTIVITY CONTOUR MAP
TEST SITE 1

10 mmho/m CONTOUR INTERVAL

LEGEND

• PROFILING STATION

SCALE-FT.

0 15 30

FIGURE 12
FILE: 85-317

McBride-Ratcliff and Associates, Inc.

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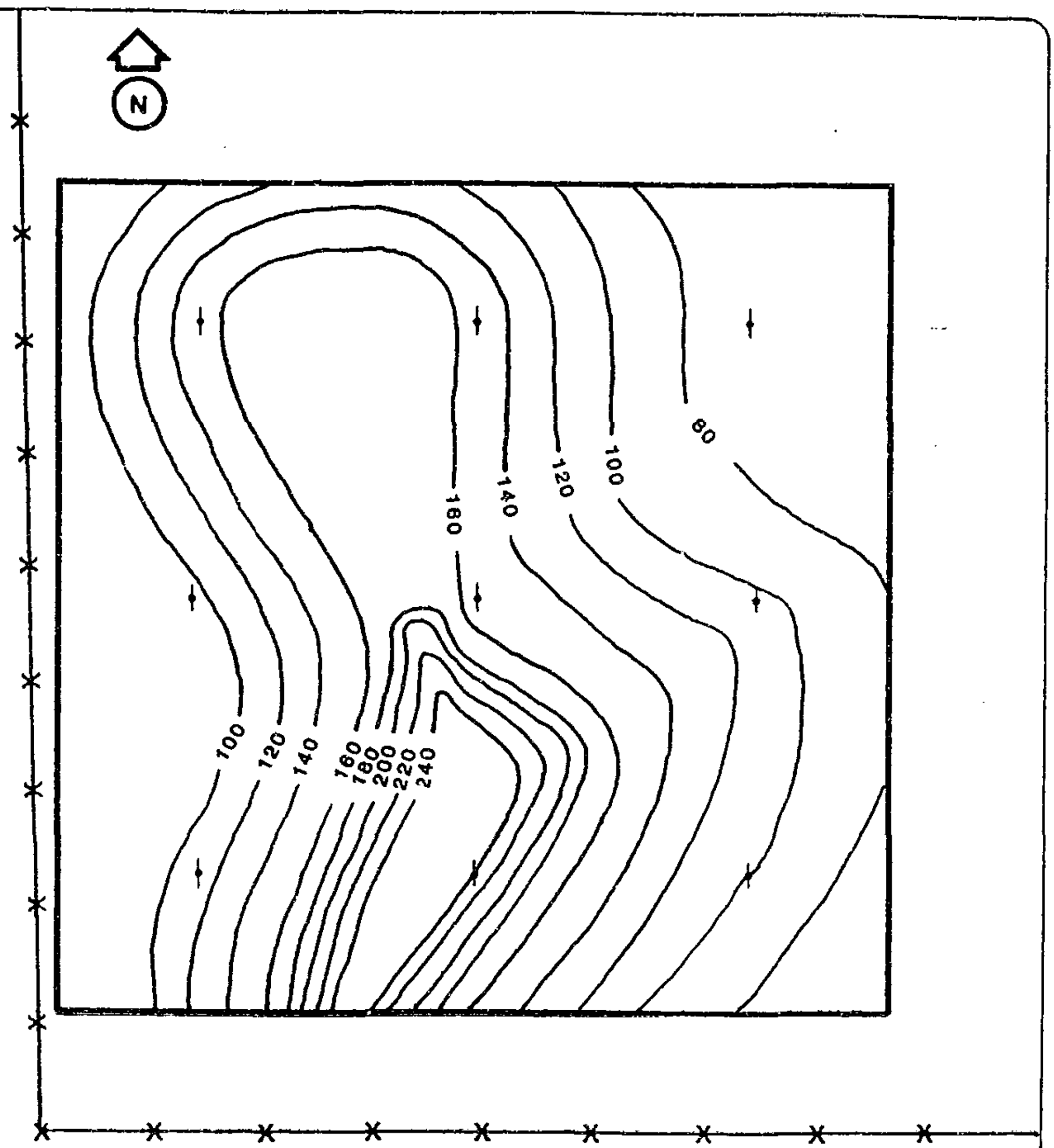

RESISTIVITY CONTOUR MAP TEST SITE 1

3 FOOT DEPTH

20 ohm/ft. CONTOUR INTERVAL

LEGEND

SOUNDING STATION

SCALE-FT.

0 15 30

FIGURE 13
FILE: 85-317

McBride-Ratcliff and Associates, Inc.

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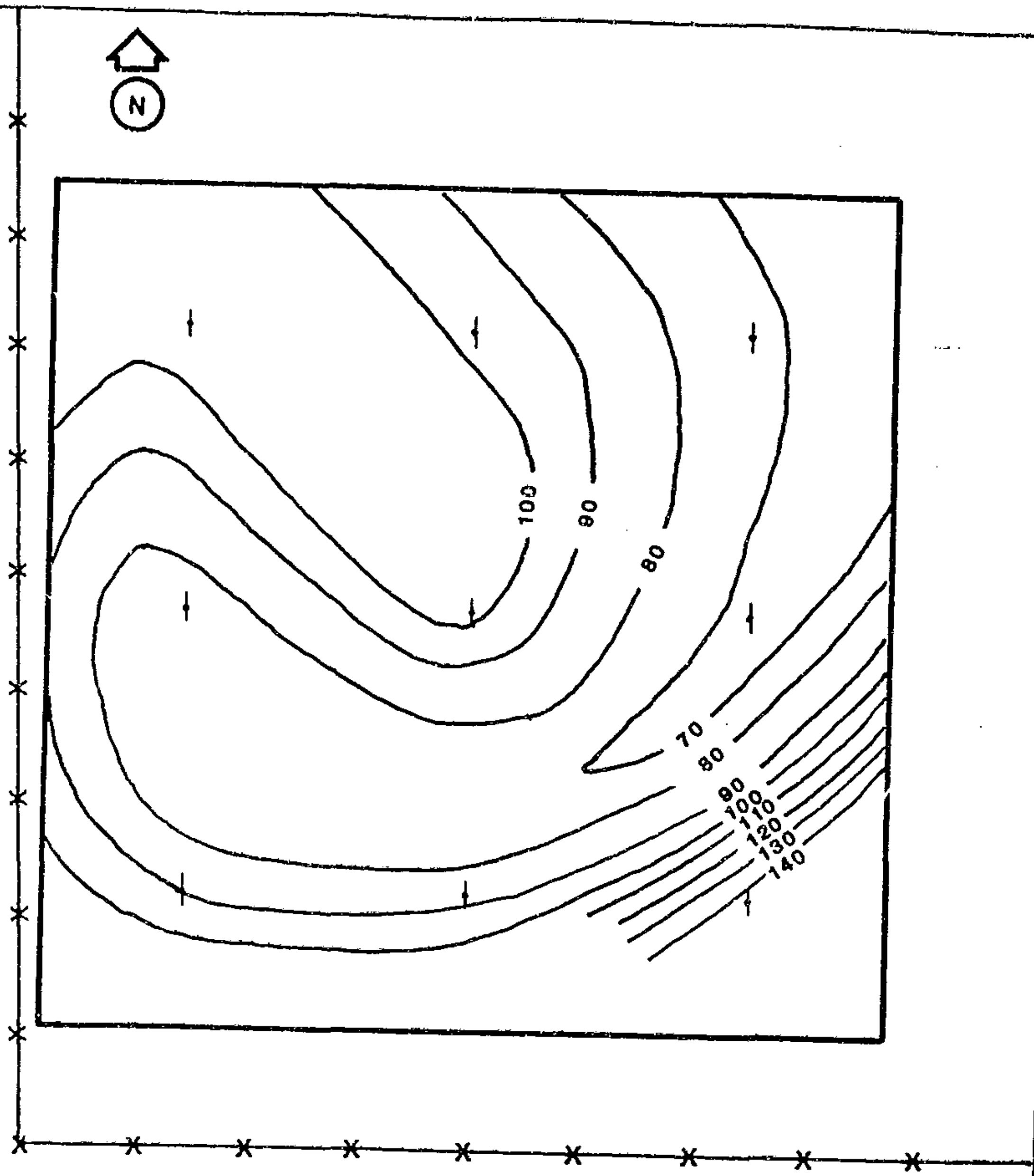

RESISTIVITY CONTOUR MAP TEST SITE 1

6 FOOT DEPTH

10 ohm/ft. CONTOUR INTERVAL

LEGEND

SOUNDING STATION

SCALE–FT.
0 15 30

FIGURE 14

FILE: 85-317

McBride-Ratcliff and Associates, Inc.

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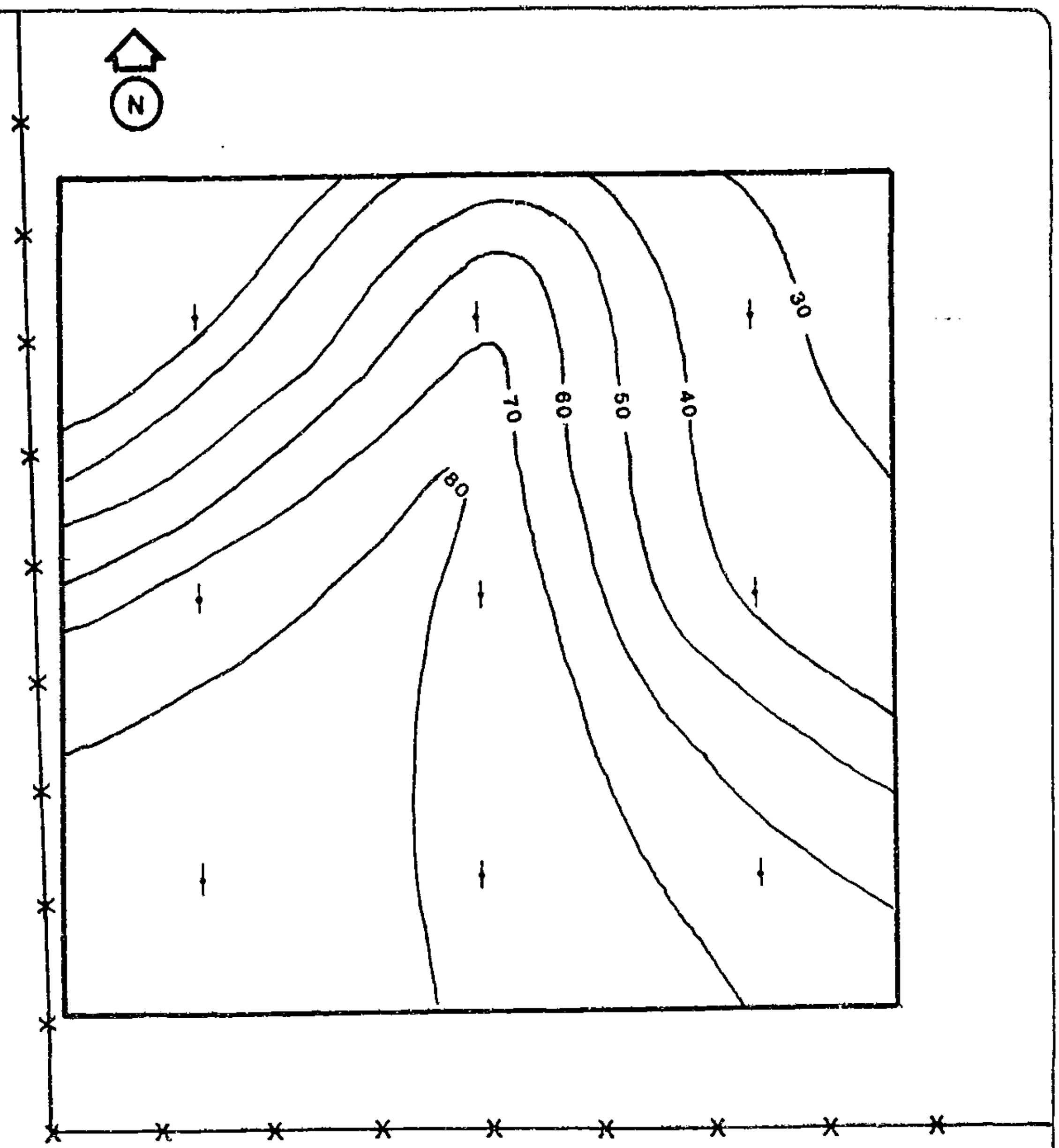

RESISTIVITY CONTOUR MAP TEST SITE 1

21 FOOT DEPTH

10 ohm/ft. CONTOUR INTERVAL

LEGEND

SOUNDING STATION

SCALE–FT.

0 15 30

FIGURE 15

FILE: 85-317

McBride-Ratcliff and Associates, Inc.

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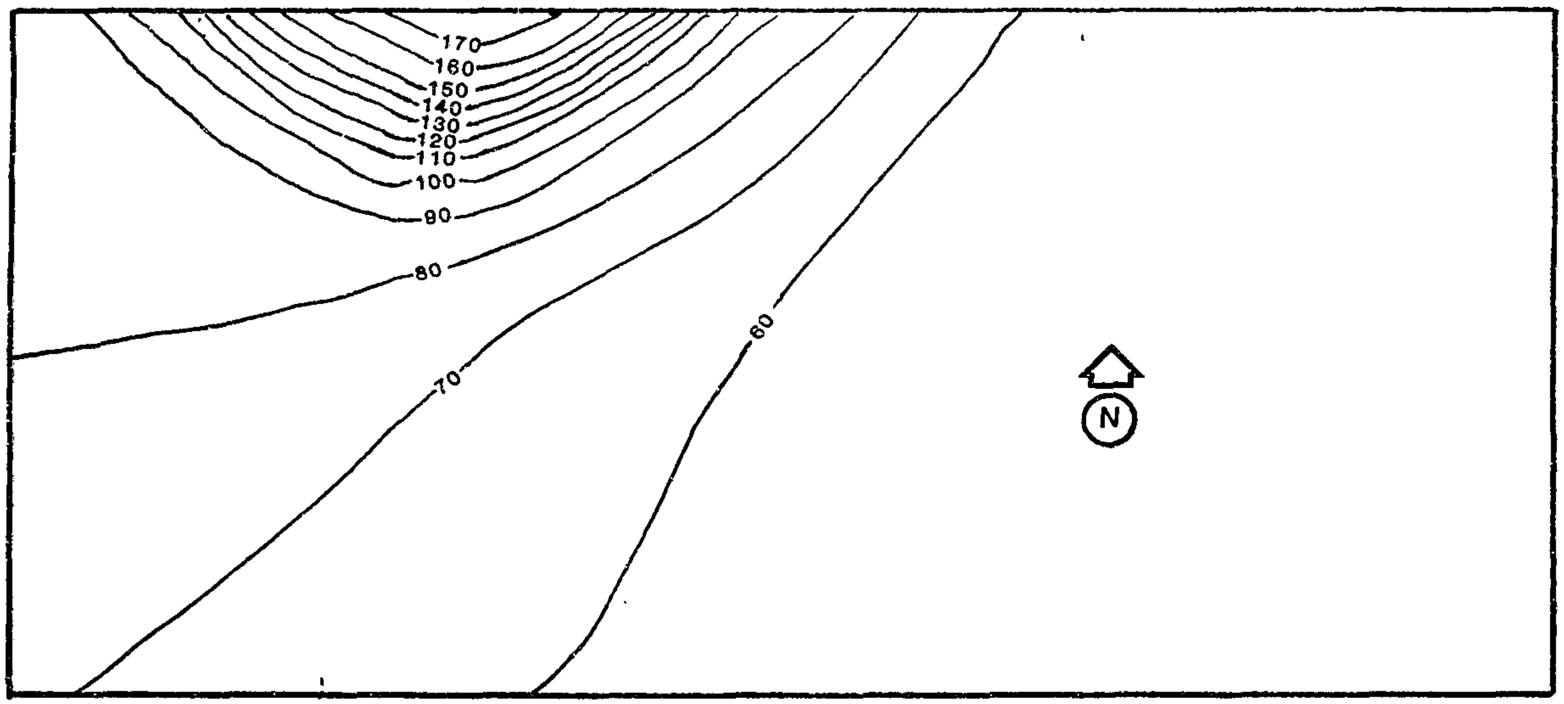


N-S CONDUCTIVITY CONTOUR MAP
TEST SITE 2

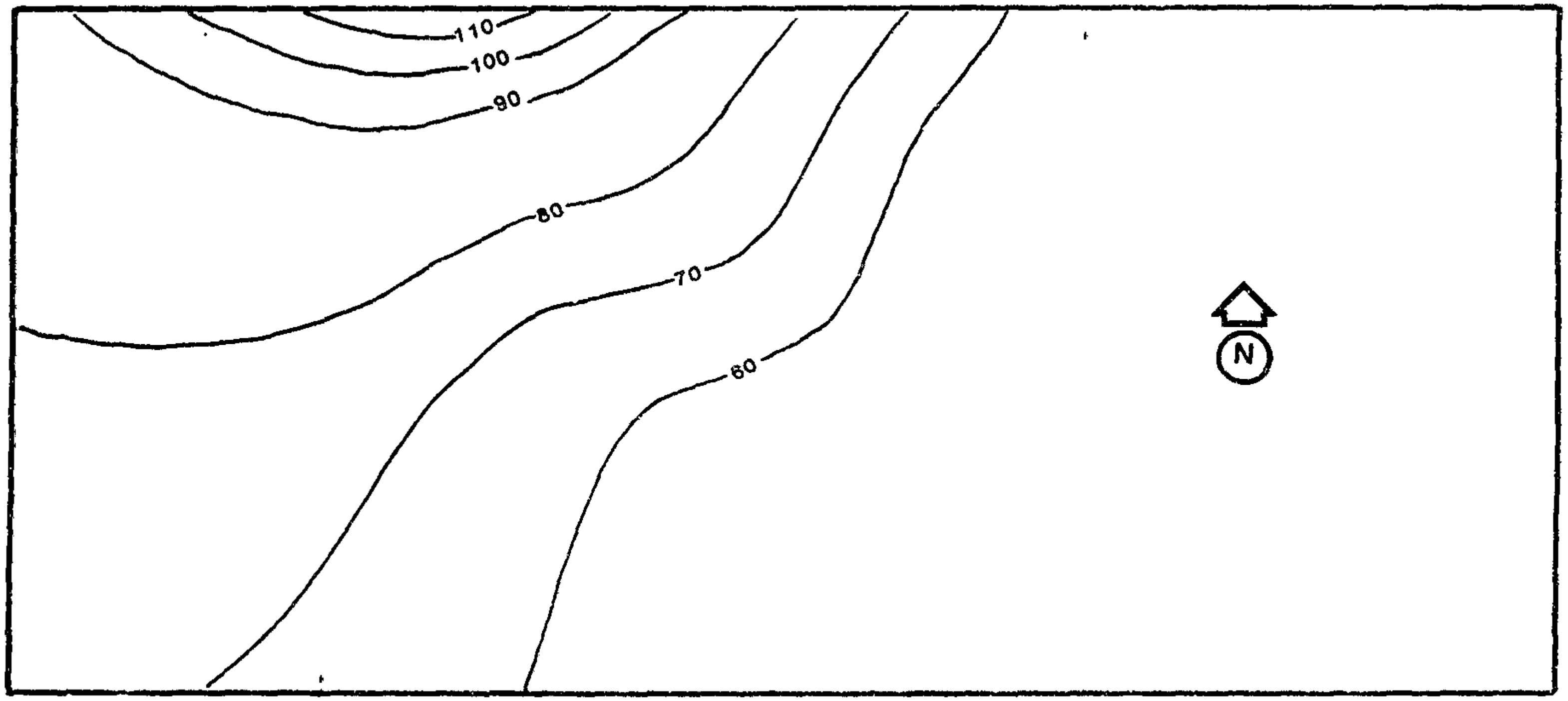
10 mmho/m CONTOUR INTERVAL

SCALE-FT.
0 5 10

FIGURE 16
FILE: 85-317

McBride-Ratcliff and Associates, Inc.

002135



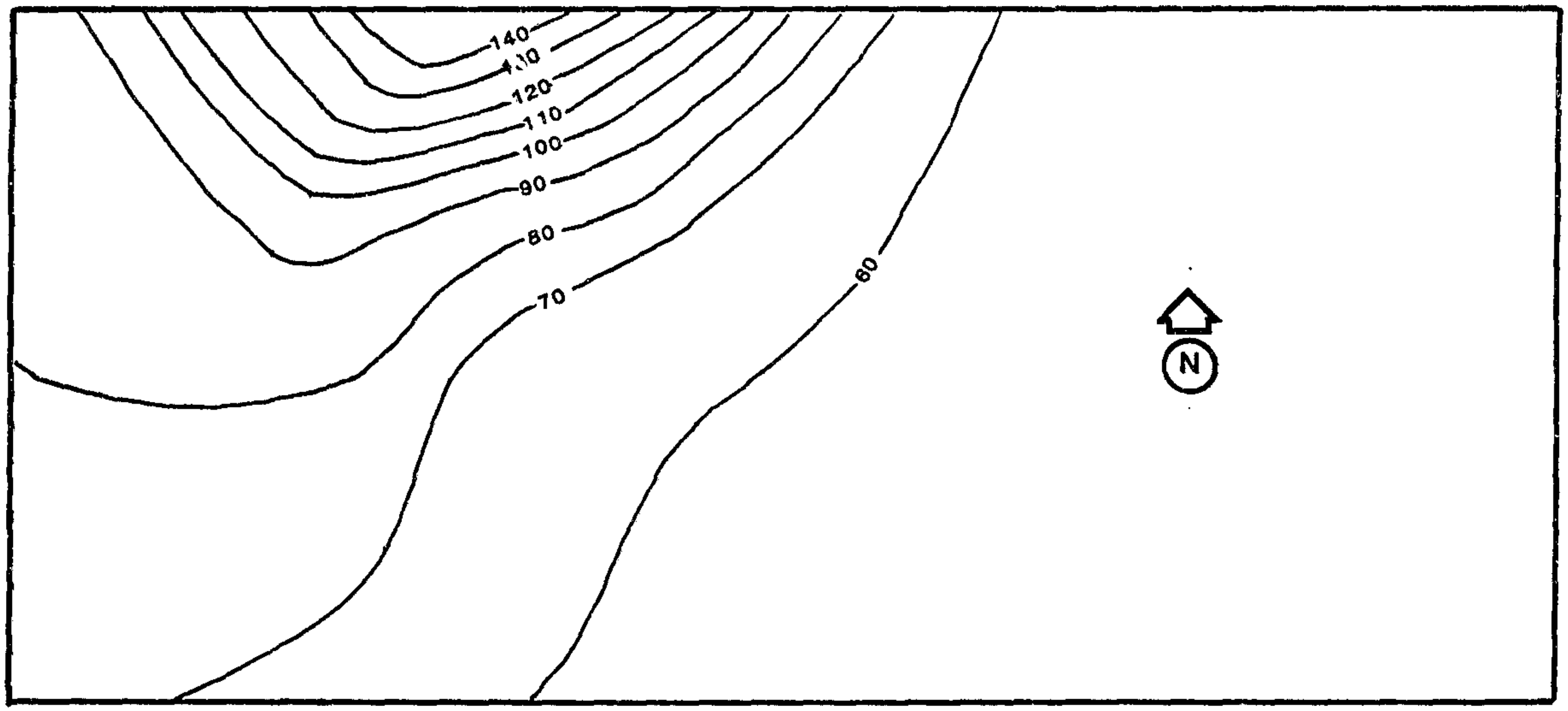
E-W CONDUCTIVITY CONTOUR MAP
TEST SITE 2

10 mmho/m CONTOUR INTERVAL

SCALE-FT.
0 5 10

FIGURE 17
FILE: 85-317

McBride-Ratcliff and Associates, Inc.



AVERAGED VALUE CONDUCTIVITY CONTOUR MAP
TEST SITE 2
10 mmho/m CONTOUR INTERVAL

SCALE-FT.
0 5 10

FIGURE 18
FILE: 85-317

McBride-Ratcliff and Associates, Inc.

APPENDIX A
GROUND-PENETRATING RADAR REPORT

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APPENDIX A

GROUND-PENETRATING RADAR FEASIBILITY SURVEY
SOUTH CAVALCADE SITE
HOUSTON, TEXAS

002139

Prepared for:

McBRIDE-RATCLIFF and ASSOCIATES, Inc.
7220 Langtry
Houston, Texas 77040

Detection Sciences, Inc.
Report No. J213-85

December 16, 1985

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APPENDIX A

INTRODUCTION AND SUMMARY

On November 20, 1985, Detection Sciences, Inc. performed a ground-penetrating radar (GPR) feasibility survey at the Koppers Company South Cavalcade Site, Houston Texas. The purpose of the survey was to evaluate the use of radar for locating subsurface contamination. The survey was performed in accordance with the requirements of McBride-Ratcliff and Associates, Inc.

Three separate locations were surveyed. Site 1, which is a grass-covered site, is located approximately 600 feet south of Cavalcade Street. Site 2, which is covered with asphalt, is located approximately 300 feet south of Cavalacade Street. Site 3 is located on Cavalcade Street, covering the traffic lanes and the turn-around in the center island. Figure A-3 shows the location of each of the three sites.

The survey utilized a custom-modified 120 MHz radar antenna. This antenna was used in conjunction with a GSSI SIR System-8 radar system which has also been custom-modified by Detection Sciences. The modified system currently provides about five (5) times greater penetration than the original sysytem. These modifications have also produced corresponding improvements in the spatial resolution and the clarity of the radar records.

The radar signatures observed over most of Site 1 indicate the presence of some type of material embedded in the soils. The material occurs in discrete "bundles" or packets. The resulting radar charts have a highly detailed, "busy" appearance as opposed to the more uniform appearance of the natural soil stratigraphy, or background conditions, observed along the fence at the west side of the property. The embedded material could be a result of evacuation and back-filling with some solid material. Another possibility is the vertical migration of liquids having relatively high viscosity, which could also produce the observed radar signatures. To establish the cause of the observed radar anomalies on Site 1, it will be necessary to use intrusive methods, such as excavation or core samples.

Radar line number 18, which runs northward from Site 1, shows undisturbed background conditions on the northern part of Site 1. On Site 2, the radar signature shows wet, saturated conditions under the asphalt, but no evidence of the inclusion of foreign material in the ground. It is likely that the asphalt is inhibiting surface evaporation of some type of liquid (possibly water), resulting in the wet conditions. At Site 3 the results are inconclusive, because the steel reinforcing bars in the concrete pavement effectively mask any radar signals underneath the road.

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DESCRIPTION OF THE SURVEY

The survey utilized a custom-modified radar antenna operating at a frequency of 120 MHz. Figure A-1 shows a 600 MHz radar antenna, which is a smaller version of the 120 MHz antenna. The antenna was mounted on a wooden sled and was towed behind a van. The survey van carried all of the electronic controls, recording equipment and power supplies, as shown in Figure A-2.

A "fifth-wheel" odometer is mounted on the rear of the survey van to log distance traveled along each survey line. The odometer wheel makes exactly 19 revolutions per 100 feet, or 5.263 feet per revolution. Each revolution of the wheel produces a "tick mark" at the top of the radar record to show the distance traveled. The location of fixed points of reference, such as lamp posts, curbs, or other physical features of the property, were electronically marked on the radar record using a hand-held event-marker switch. The marker switch generates a vertical dashed-line on the radar record. By using this marking system with the odometer wheel and physical features, it is possible to maintain position accuracy within 1 foot.

All radar data is permanently recorded on a Model 3964A Hewlett Packard 4-channel Instrumentation Tape Recorder. Hard-copy records of the radar charts are produced by Model 2200S EPC Scanning Chart Recorder. The basic approach is to use field time to accomplish the electronic data-gathering, reserving the interpretation and analysis for the laboratory. Field time is reduced to about 20 percent of the total time required to process the data. (Using so-called "real-time" methods requires all of this work to be accomplished under field conditions; keeping a crew in the field and having the equipment idle is much more costly and less productive than having one person analyze the data in the laboratory.)

Having the radar data recorded on magnetic tape makes it possible to produce multiple hard-copies of the radar records. The tape-recorded data also makes it possible to perform post-survey signal processing and data enhancement using a variety of analog and digital methods. In most cases, the raw data collected in the field can be expanded to achieve about 50 percent greater penetration in the ground. It is also possible to enhance certain features, such as deep-lying strata or subsurface cavities. In effect, the tape-recorded data preserves all of the radar signals originally observed by the antenna, making it possible to perform after-the-fact optimizations of control settings and other survey variables.

For this survey, the depth setting of the radar system was 24 feet. The resulting display has a vertical scale factor of 2 feet per inch on a 12-inch graphic chart.

.002142

002143

Figure A-1

600 MHz RADAR ANTENNA

The operator is guiding the 600 MHz radar antenna along the surface of the ground to generate vertical profile charts. The handle has an electrical button which electronically annotates the ground locations on the radar charts. Extending from the left of the antenna unit is an electrical cable (up to 500 feet in length) which connects with the rest of the radar system.

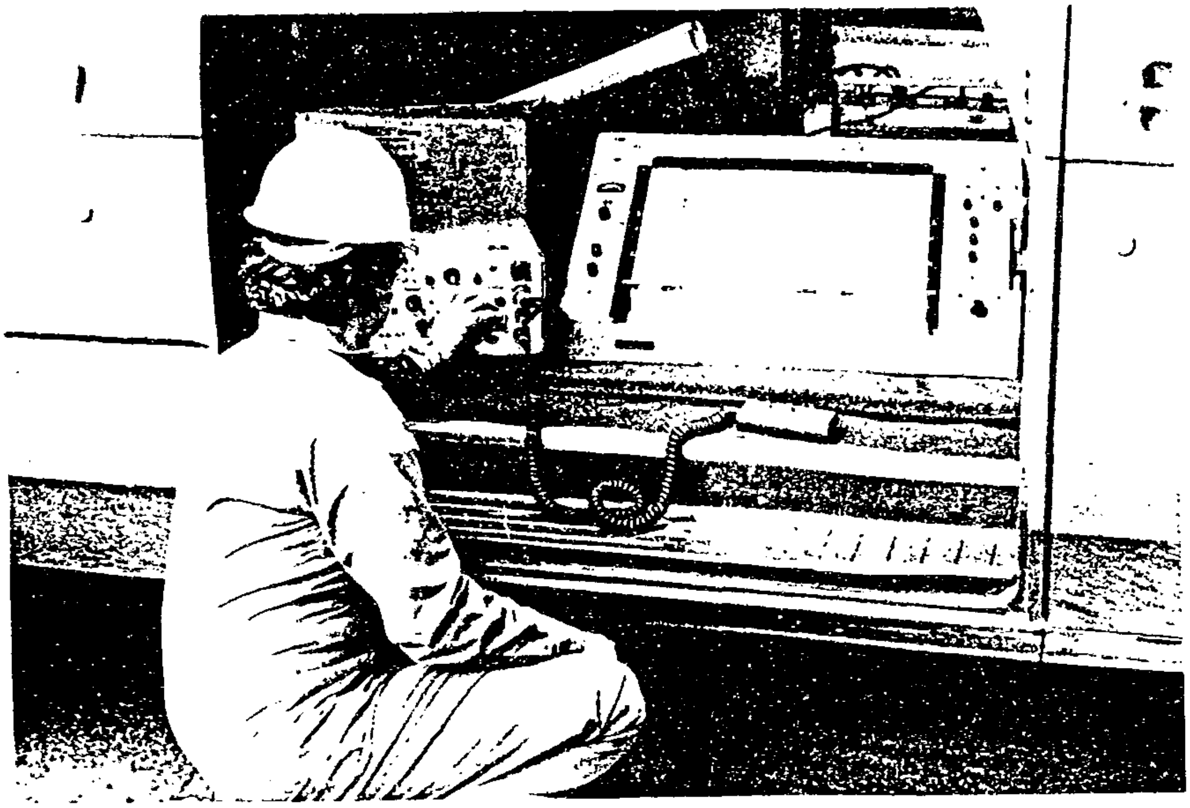


Figure A-2

CHART RECORDER AND RADAR CONTROLS

The radar equipment is carried in a van, where the operator is adjusting the controls. To the right of the operator is the chart recorder which generates vertical profiles of the ground. The power supply and the four-track tape recorder are not shown. Normally, the van is used to tow the radar antenna over the ground, but the antenna can also be pulled along by hand.

002144

METHODOLOGY

The bulk of the survey consisted of parallel survey lines spaced 10 feet apart. Some "cross-cut" lines were also run. The radar antenna covers a path about 5 feet wide at the surface of the ground. A 10-foot spacing between adjacent lines provides 50 percent coverage of the area surveyed. (Survey lines separated by 5 feet would provide 100 percent coverage.)

Surface coverage, however, is not the only consideration. As the radar beam penetrates into the ground, the beam spreads about 20 degrees on each side (40 degrees total beam angle). At a depth of approximately 14 feet, the beam has spread to a total width of 10 feet, which is the same as the spacing between the survey lines. As a result of this beam spread, there is 100 percent area coverage at a depth of 14 feet. At depths greater than 14 feet, there is more than 100 percent coverage due to beam overlap.

The volume of earth that is not inspected with a 10-foot spacing is an inverted V-shaped "furrow" which is 5 feet wide at the surface, tapering to a point at a depth of 14 feet. Depending on the total depth of the survey, the volume of material that is not inspected constitutes no more than a small fraction of the total volume of earth inspected by the survey. The 10-foot spacing between adjacent survey lines used for this survey therefore covers a high percentage of the total volume of earth below the surface.

002145

RESULTS OF THE SURVEY

The survey consisted of three individual sites, designated as Site 1, Site 2, and Site 3. Site 1 is a grass-covered area approximately 600 feet south of Cavalcade Street. Site 2 is an asphalt-covered area approximately 300 feet south of Cavalcade Street. Site 3 is on the concrete pavement of Cavalcade Street, located at the north entrance drive into the property. Figure A-3 shows the location of each of these three sites.

Site 1.

Figure A-4 is an expanded-scale plan view of Site 1. The radar lines are numbered in the sequence in which they were run. The darker shading shows the area over which subsurface radar anomalies were observed. The native soils should have relatively uniform soil horizons or stratigraphy. Instead, there appears to be some type of material embedded in the soils. The material occurs in discrete "bundles" or packets, and is not uniformly distributed in the soils. This embedded material gives the radar charts a highly detailed "busy" appearance in contrast to the more uniform, benign appearance of background data obtained at the western edge of the property.

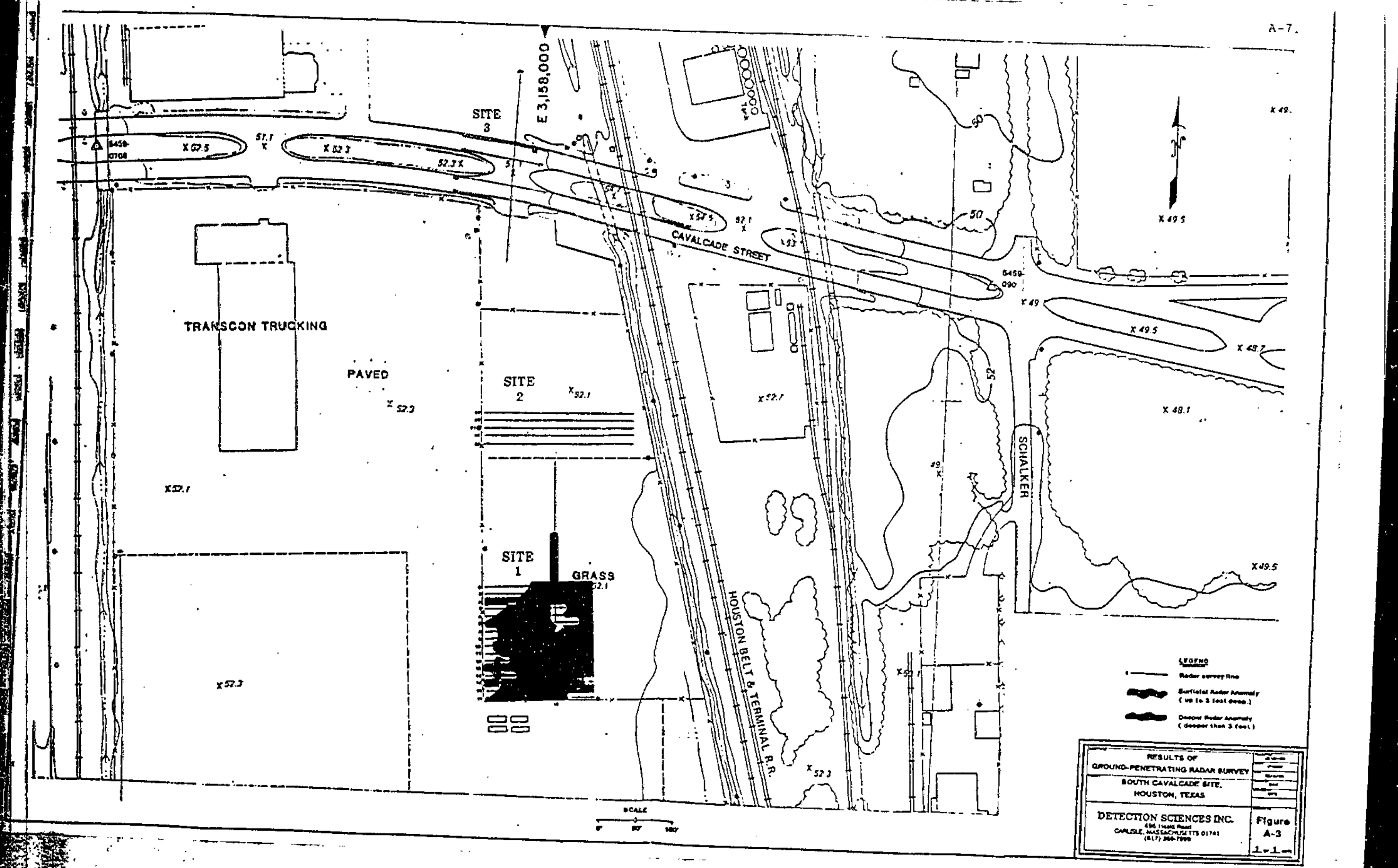
The lighter-toned shading indicates the areas where the soil inclusions are surficial, being contained in the upper three feet of the earth. In the areas labeled "surficial anomalies" (Figures A-3 and A-4), there does not appear to be any involvement of the underlying clay.

Site 2.

Figure A-5 is an expanded-scale plan view showing the radar survey lines on Site 2. This area is covered with asphalt. Beneath the asphalt pavement, the radar signatures are typical for wet, saturated conditions. This type of signature indicates the presence of some type of non-ionic (non-electrically conducting) liquid. The liquid could possibly be water. Is is likely that the asphalt is inhibiting surface evaporation of the liquid. It is also probable that the thermal effects of the pavement are influencing the behavior of the underlying liquids. Black asphalt is a good absorber of solar energy. The pavement acts as a heat blanket to absorb and store heat. This heat source can influence the capillary action of the underlying soils by decreasing the viscosity of liquids trapped under the pavement. There can also be upward migration or "pumping" of trapped liquids due to volitization and condensation cycles caused by diurnal tempertaure changes.

There is no evidence of increased electrical conductivity under the asphalt pavement. This means that the liquid or moisture trapped under the asphalt cannot be an acid, base, salt, or any other electrolyte (ionic liquid). It should be noted that the detection threshold of the radar system for detecting ionic (electrically conducting) liquid is a concentration of a few parts-per-million (ppm). If the concentration is below this level, the liquid will not be observed.

002146


E 3,158,000
SITE 3
CAVALCADE STREET
TRANSCON TRUCKING
PAVED
SITE 2
SITE 1
GRASS
HOUSTON BELT & TERMINAL R.R.
SCHALKER
LEGEND
Radar survey line
Surficial Radar Anomaly
(up to 3 feet deep)
Deeper Radar Anomaly
(deeper than 3 feet)
RESULTS OF
GROUND-PENETRATING RADAR SURVEY
SOUTH CAVALCADE SITE,
HOUSTON, TEXAS
DETECTION SCIENCES INC.
CARLISLE, MASSACHUSETTS 01741
Figure
A-3
SCALE

DETECTION SCIENCES, INC.

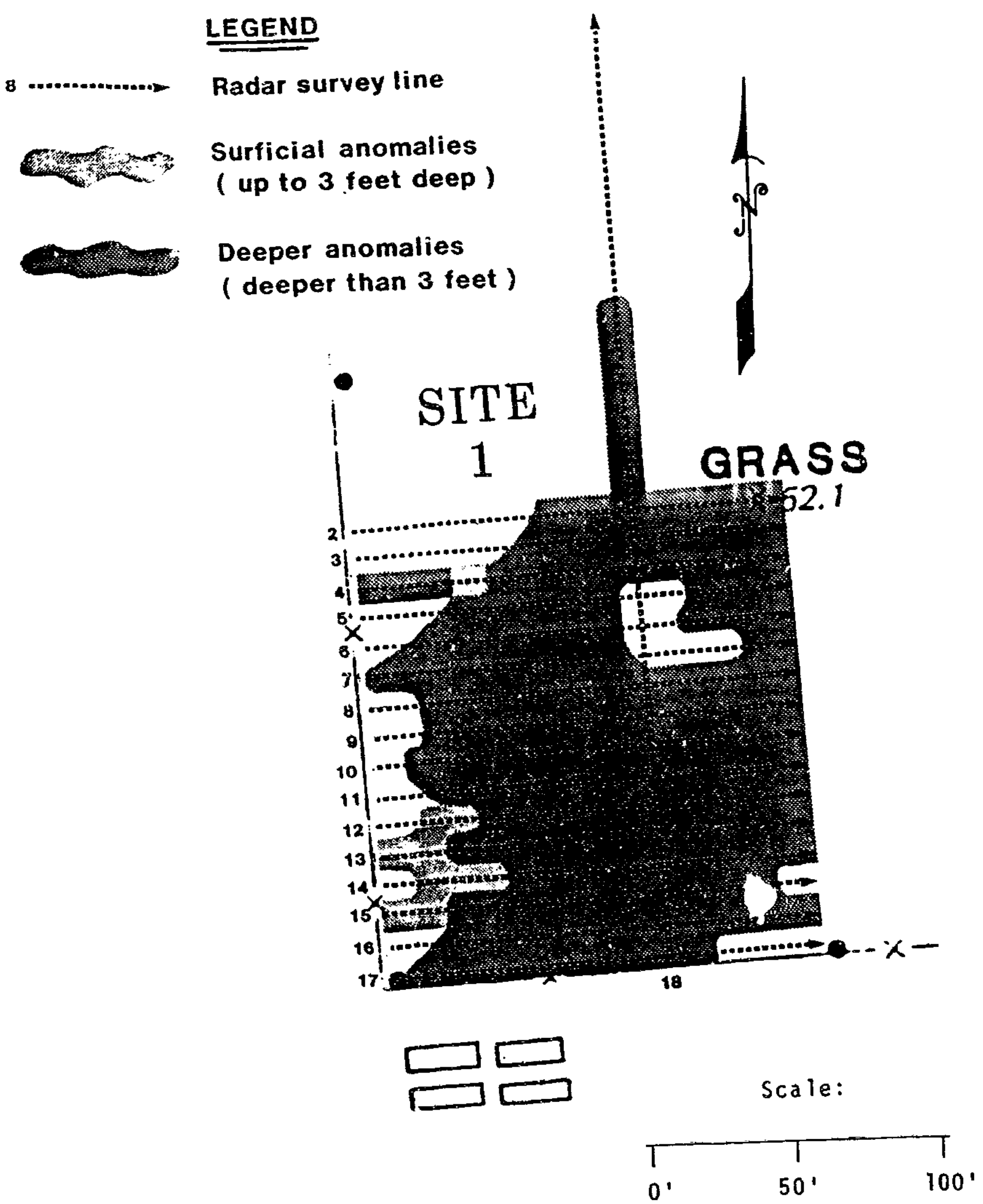
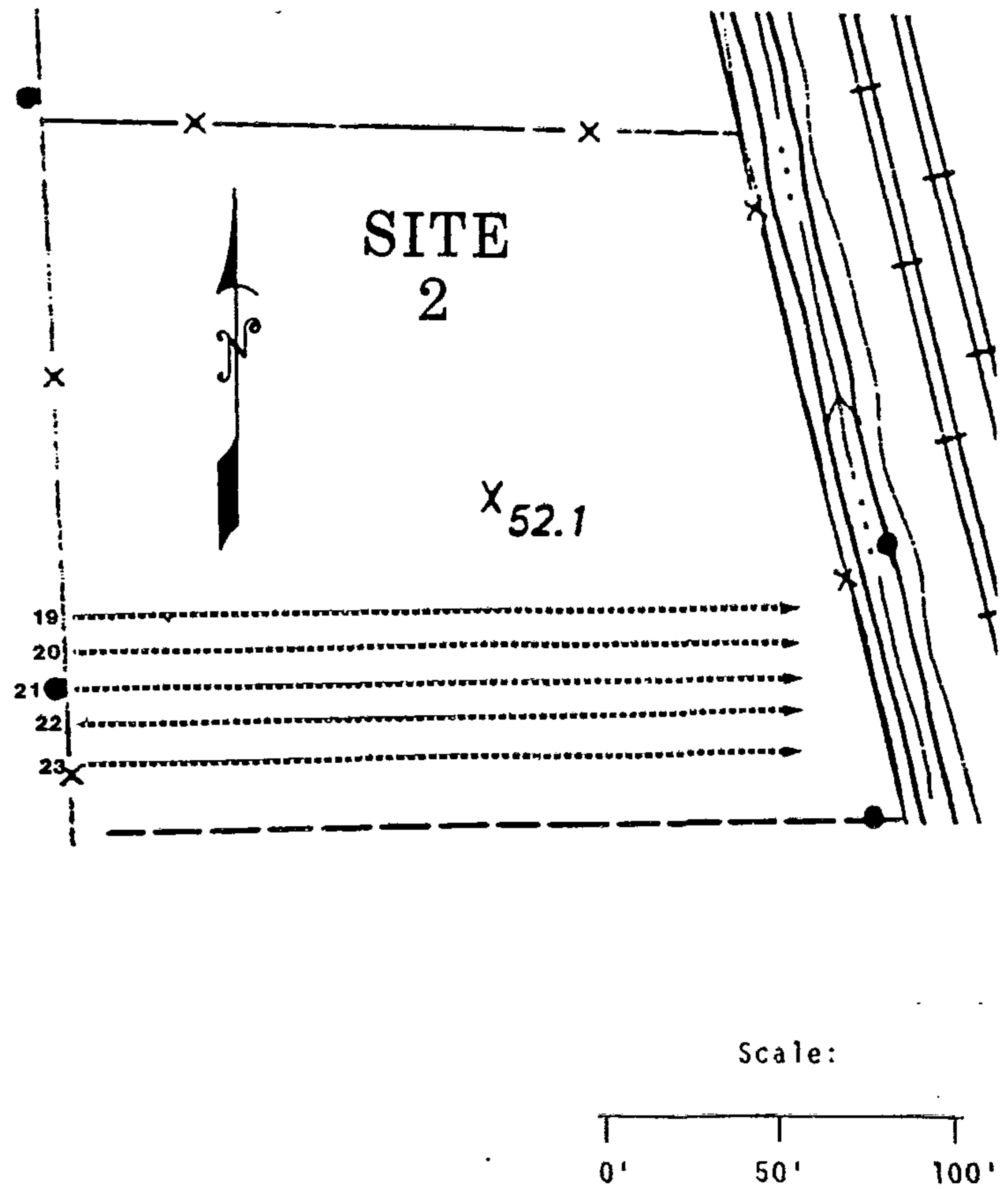


Figure A-4

Grass-Covered Area

002148



002149

Figure A-5

Asphalt-Covered Area

Site 3.

Figure A-6 is an expanded-scale plan view of Site 3 on the concrete roadway of Cavalcade Street. Prior to undertaking the survey, we were concerned about the existence of reinforcing steel in the concrete roadway. Steel (or any metal) is 100 percent reflective of radar energy. At 120 MHz, the steel reinforcing acts as a reflecting screen, effectively masking any reflections that would be observed below the steel.

Our concerns were well founded, as the concrete pavement was found to have steel reinforcing bars (not steel mesh) embedded in the concrete. The radar results on this site are inconclusive, because the reflections from the steel effectively mask any underlying reflections. In the past, we have experimented with computer-processing of data to subtract the effect of the steel. To succeed with this approach, the thickness of the pavement, the depth of the steel rebars below the surface of the pavement and other factors must remain constant. The computer program memorizes a running average over a large number of radar scans, and subtracts the composite average from the incoming radar scans. The net effect is to remove all data that is constant, allowing only the scan-to-scan changes to be observed. In military jargon, this type of radar signal-processing is called "MTI" (moving target indicator), the purpose of which is to remove all of the stationay background. If the "background" which is to be subtracted also changes, this approach for the removal of background will not be successful. Inspection of the radar charts for this site shows there is sufficient variability in the reflections from the rebars to prevent the successful use of background-removal algorithms.

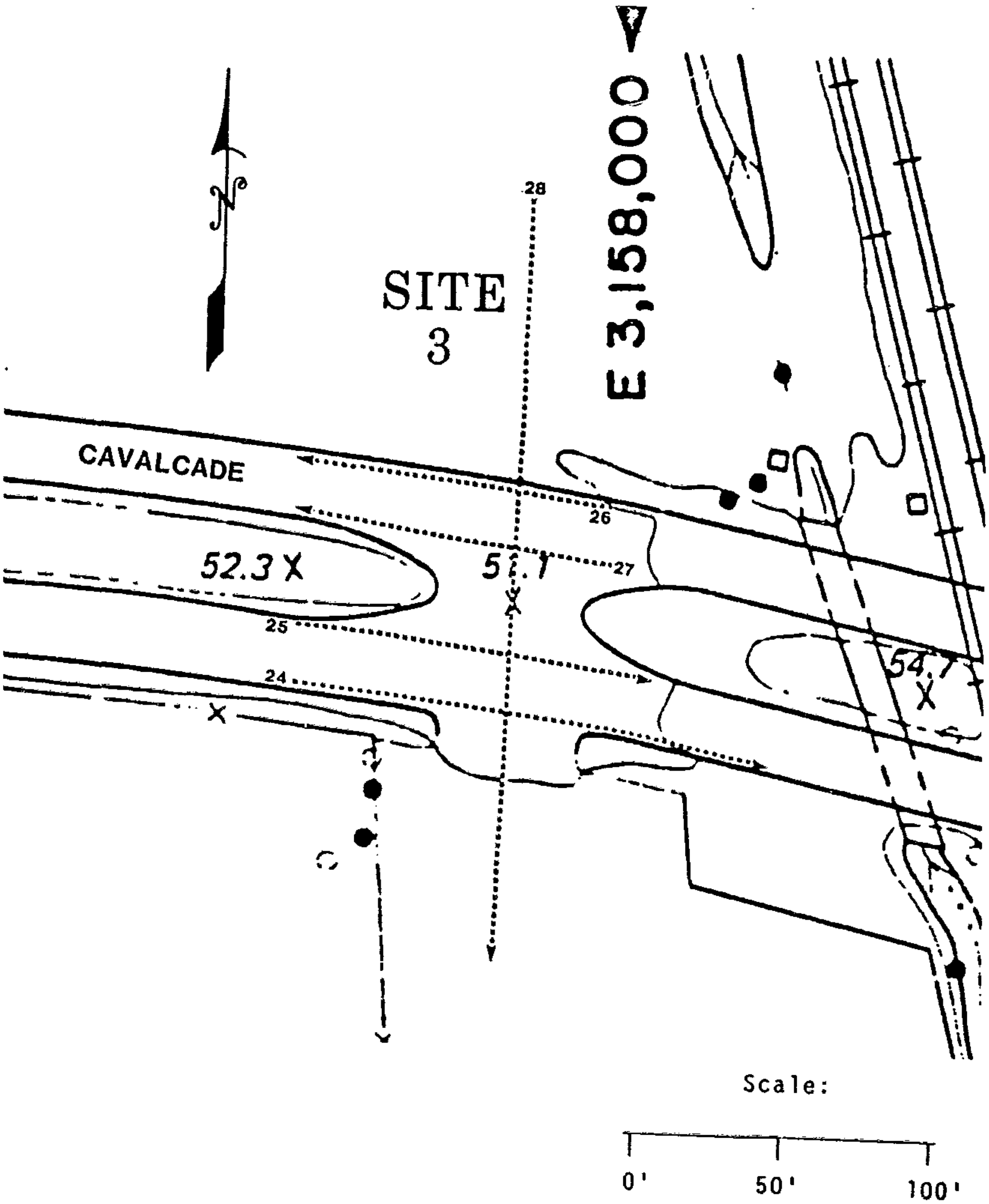


Figure A-6

Concrete-Paved Area

DISCUSSION OF THE RESULTS

Background Conditions.

Experience has shown that different sites can vary widely in their radar characteristics. The type of soil, the soil-moisture conditions at the time of the survey, and other variables produce characteristic radar signatures that constitute the "norm" for each site. When dealing with chemical contamination in the ground, it is essential to establish the norm, or background conditions, against which any abnormal condition can be judged. It is only in comparison with the norm that an anomaly, or departure from the norm, can be identified.

To determine what constituted background conditions, survey line number 29 was run along the fence at the western boundary of the property. Figure A-7, a segment of this survey line, shows uniform, undisturbed conditions. This is the type of radar signature that is normally observed in the Houston area. We therefore believe that this data is representative of background conditions.

The vertical scale of Figure A-7 and all Figures that follow is 1 inch = 2 feet. The odometer "tick marks" at the top of the chart are spaced 5.263 feet apart. This radar chart has not been computer-processed or signal-enhanced; it is a direct analog print-out of the radar data tape-recorded in the field.

Subsurface Radar Anomalies.

Figure A-8 shows a segment of survey line number 18 at Site 1. The radar system is imaging some type of discrete inclusions, or packets of material, in the ground. It is possible that the inclusions could be some type of solid material. It is also possible that the inclusions are due to the vertical migration of semi-viscous liquids. The vertical migration of semi-viscous liquids have a distinctly different radar signature compared to low viscosity or high viscosity liquids. Low viscosity liquids tend to disperse uniformly in the soil; high-viscosity or semi-solid liquids typically agglomerate, and tend to remain where they have been placed in the ground. It is only in the case of semi-viscous liquids that vertical migration can produce distinct vertical "columns" of anomalies such as the type of anomaly observed at Site 1.

Surficial Radar Anomalies.

Figure A-9 shows the western segment of radar survey line 13 at Site 1. The left portion of the chart shows essentially background conditions below 3 feet. Above this depth, the radar anomalies appear the much the same as they do elsewhere on this chart. The areas where the radar anomalies appear to be confined to the upper 3 feet have been designated as surficial anomalies. Compared to the bulk of Site 1, where the radar anomalies extend up to 9 feet deep or more, this confinement within the upper 3 feet could be significant.

00215 2

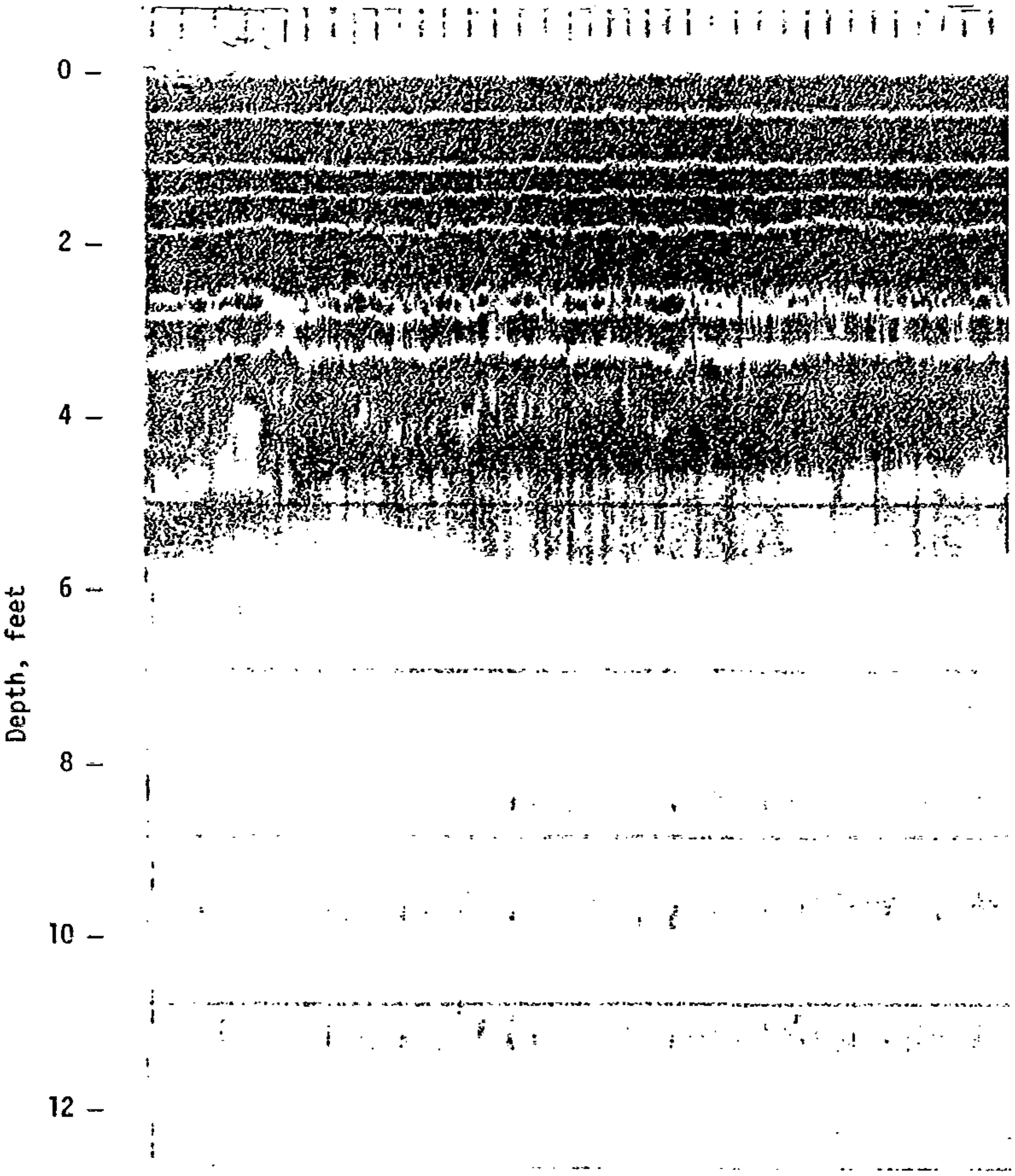


Figure A-7

Radar data showing background conditions.
This chart is a segment of radar line number 29.

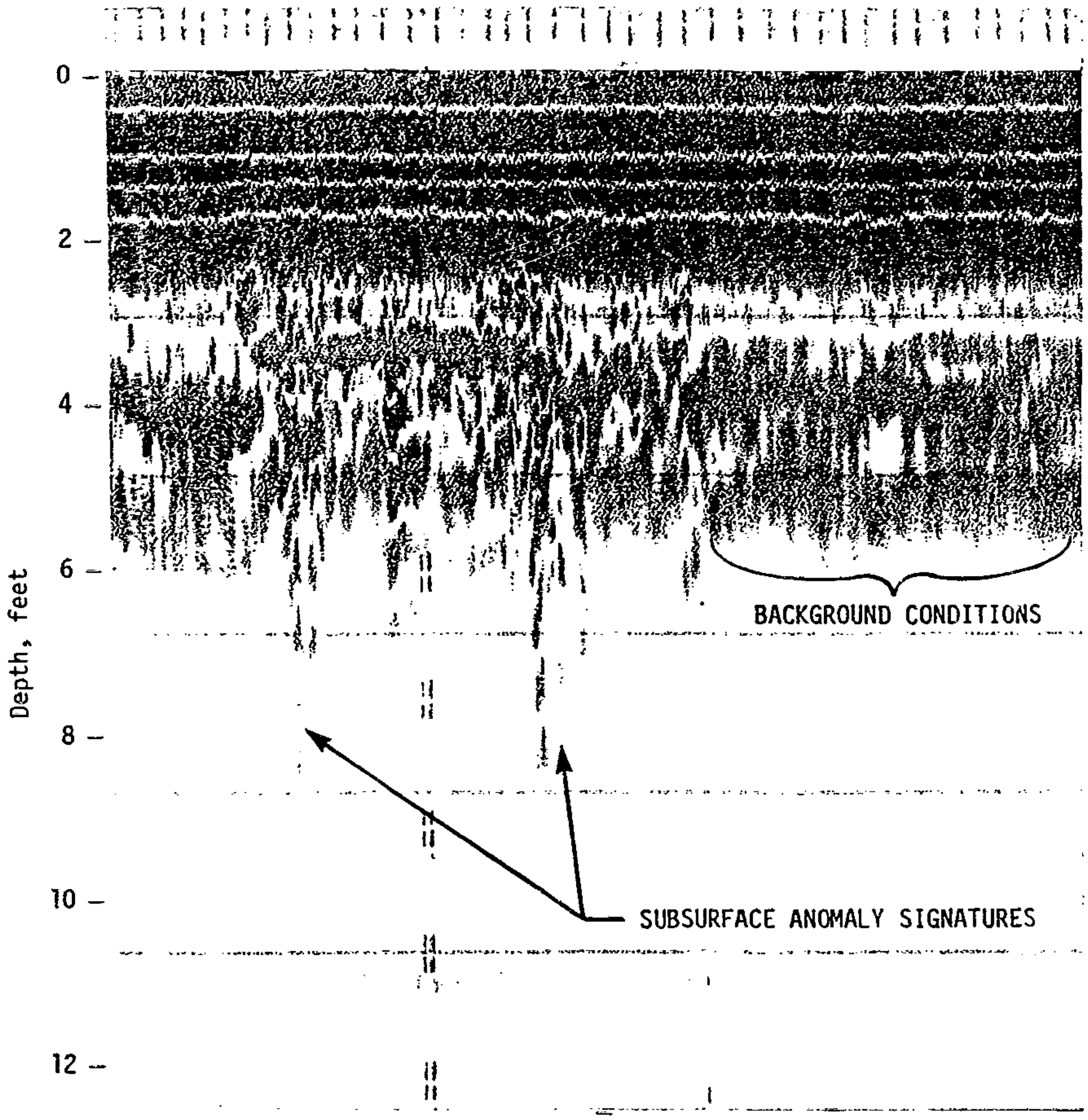


Figure A-8

Radar data showing subsurface anomalies on Site 1.
This chart is a segment of radar line number 18.

002154

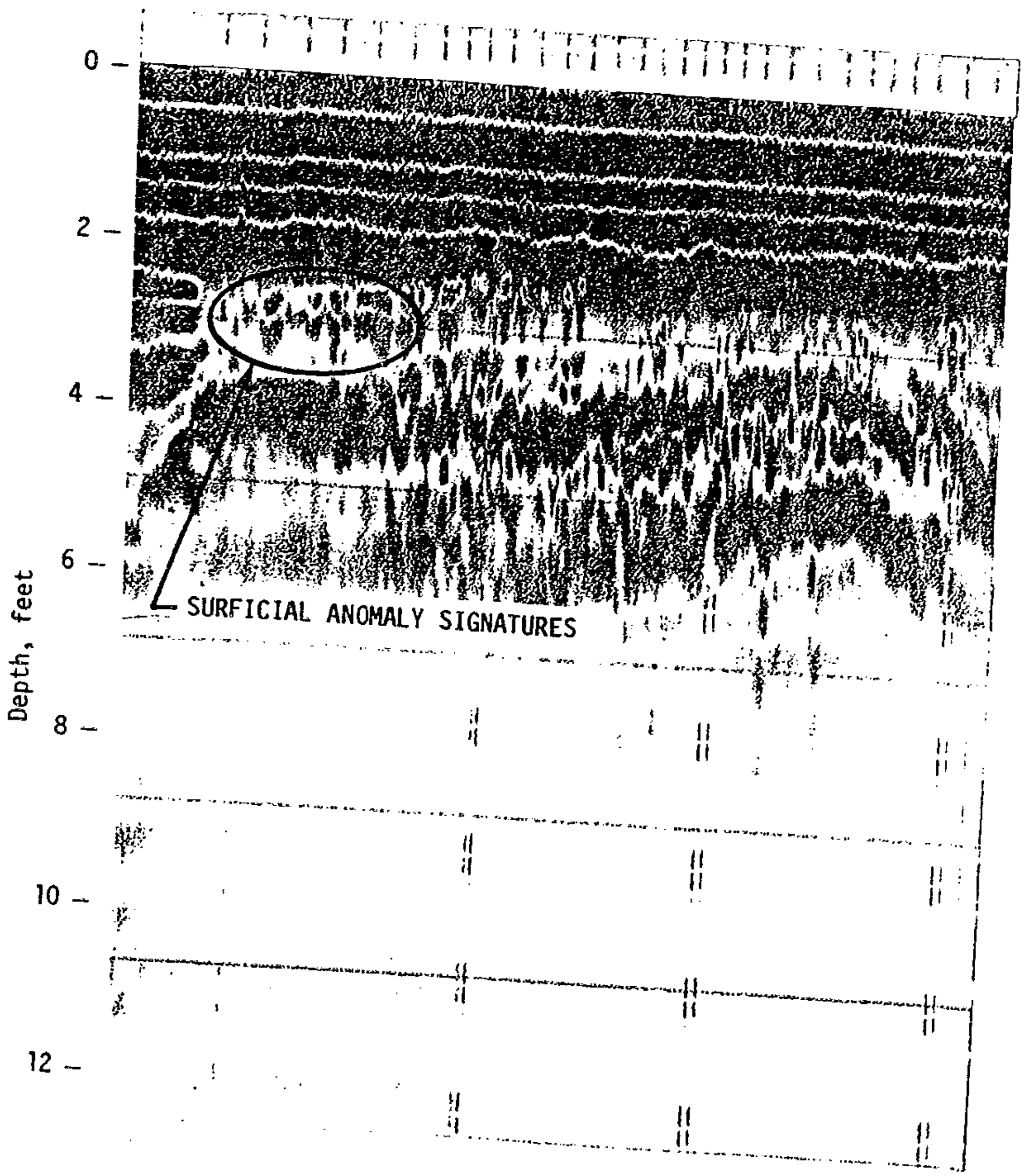


Figure A-9

Radar data showing surficial radar anomalies.
This chart is a segment of radar line number 13.

002155

Asphalt Area.

Figure A-10 shows a segment of radar survey line 21, which is in the asphalt-covered area of Site 2. The signatures are consistent over all of the asphalt-covered area. The dark, heavy banding of the radar reflections are charactertistic signatures for wet, saturated conditions under a paved area where the pavement inhibits surface evaporation.

Concrete Pavement.

Figure A-11 shows a segment of radar survey line 24. The steel reinforcing produces the characteristic "fringe" observed in the upper portion of the chart. The 120 MHz radar antenna used for this survey is a "time-shared" antenna. At the beginning of each radar scan, or impulse, the radar transmitter is coupled to the antenna. After the initial impulse, which lasts a few billionths of a second, the transmitter is electronically decoupled from the antenna, and the radar receiver is then coupled to the same antenna. This high-speed switching is accomplished by a transmit-receive switch (T-R switch). During the time period that the receiver is not coupled to the antenna, it is esentially "blind", being unable to receive any echoes from beneath the ground. This "blind zone" starts at the surface of the ground, and is typically about 30 inches deep. The rebars are only a few inches below the surface of the pavement, and therefore fall within the blind zone. The effects of the rebars, or "shadows" cast by the rebars, extend deeper into the ground, where they can be observed during the portion of the scan cycle when the receiver is coupled to the antenna.

To obtain data from the upper 30 inches of depth, it would be necessary to employ a higher frequency antenna with a corresponding sacrifice in total depth. By using smaller, higher frequency antennas, a single antenna can be used as the dedicated transmitter, with another antenna being used as the dedicated receiver. With this arrangement, the physical size of each individual antenna must be sufficiently small so as to make the center-to-center distance between the two antennas about 12 inches or less. (The physical spacing between two 120 MHz antennas would be about 3 feet, which is not an appropriate geometry for near-surface investigation. Because the principal interest on this survey was at depths of more than 30 inches, the time-shared 120 MHz antenna is the optimum choice for the survey.

The horizontal distance between each "fringe" indicates that the rebars are on 24-inch centers. Although the radar signatures below the pavement appear to be similar to background conditions, the effects of the rebars cannot be ignored. The rebar signatures tend to mask other signatures, and therefore reliance should not be placed on the absence of a signature. In this particular case, a negative result should be regarded as inconclusive rather than regarded as being conclusive.

002156

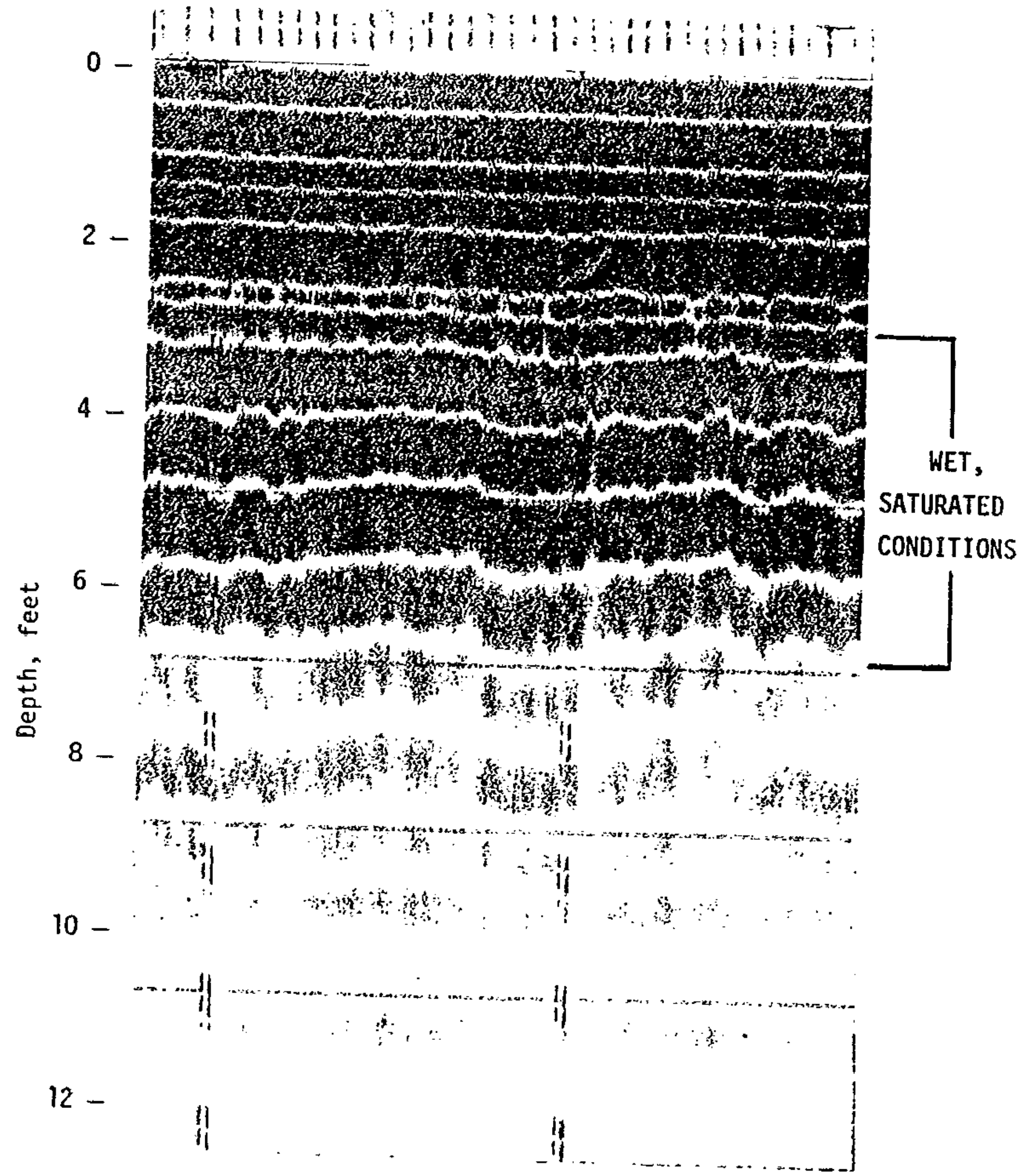


Figure A-10

Radar data showing effect of asphalt pavement.
This chart is a segment of radar line number 21.

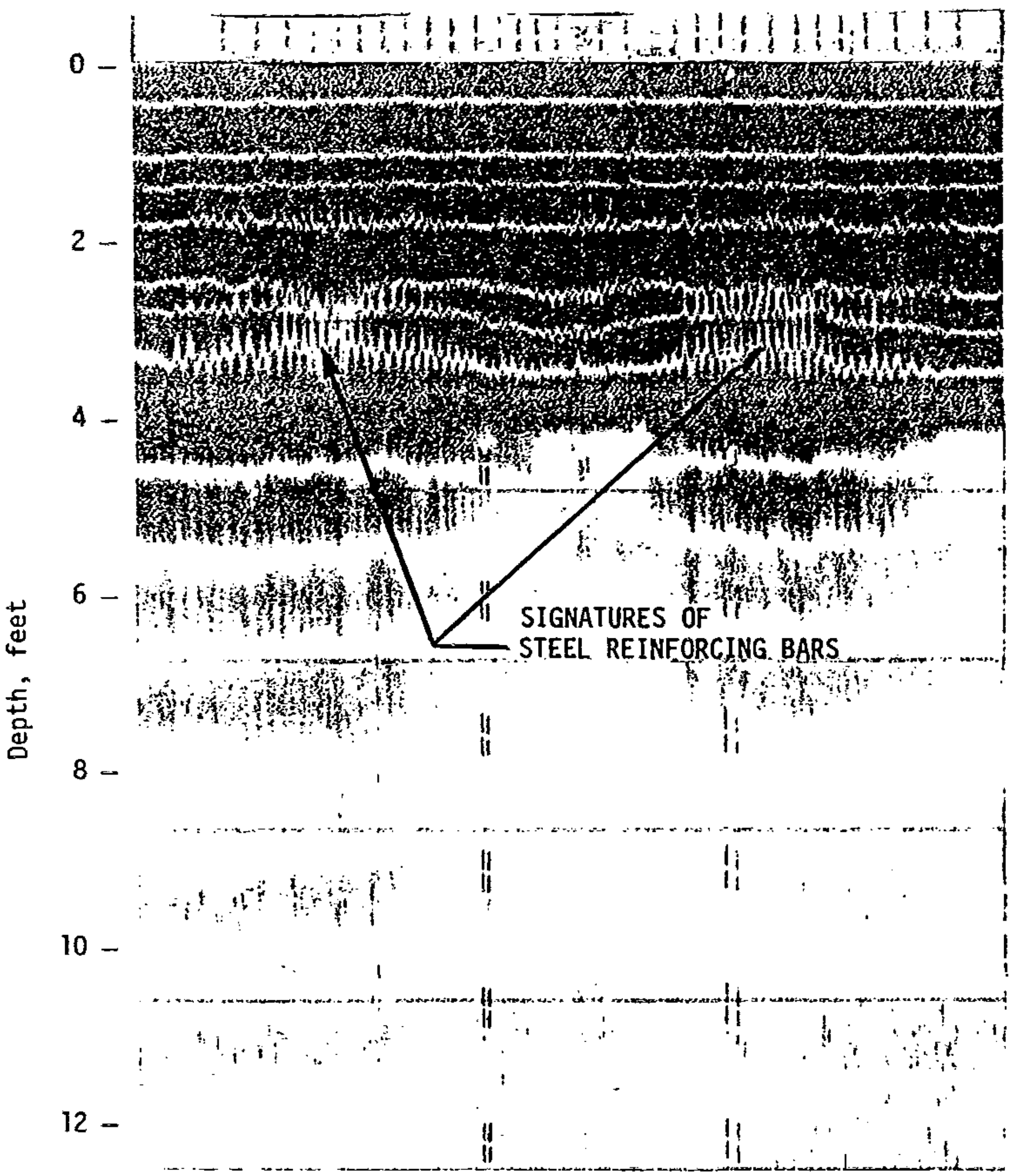


Figure A-11

Radar data showing effect of rebars in concrete pavement. This chart is a segment of radar line number 24.

CONCLUSIONS

In the opinion of Detection Sciences, Inc., this survey established the feasibility of using ground-penetrating radar (GPR) on the grass-covered portions of this property. The radar anomalies on Site 1 were clearly evident, and differed markedly from background conditions.

On the asphalt-covered portions of the survey (Site 2), the radar survey found wet, saturated conditions under the asphalt. The trapped liquid may be water, which would not be of any consequence. The wet, saturated conditions, however, could be due to some non-ionic liquid(s) other than water, in which case chemical analysis would be necessary to identify the liquid.

On the concrete-paved portion of the survey, reflections from the steel reinforcing bars effectively mask any subsurface reflections below the pavement. The radar data obtained on Site 3 is therefore inconclusive.

The cause of the anomalies on Site 1 can be attributed to two possible sources. One is the burial of some type of material. The other is the vertical migration of semi-viscous liquids into the ground. It is also possible to have a combination of these two conditions. To determine the specific cause of the observed radar anomlies, it will be necessary to use intrusive methods of investigation.

In some respects, the limited size of each of the three survey sites was a handicap, much like looking through a key-hole in an attempt to peer into a room. With such a small sample, it is not possible to make any assessmemts about the condition of the property at large. On Site 1, for example, it appears that the anomalies extend beyond the area covered by the survey. With limited data, the full extent of the radar anomalies is not known. On Site 2, the wet, saturated conditions observed under the asphalt may not extend over the entire asphalt-paved area, but there is no data outside of the survey area to make this determination.

Prior to undertaking the radar survey, there was concern on the part of others that GPR would not be able to provide adequate penetration of the clay on the site. Because we are using a modified radar system which provides about 5 times more penetration than a standard, commercial radar system, it was the opinion of Detection Sciences that we would be able to map the lateral extent of any anomalies in the upper soils and in the upper clay. Based on the quality of the data obtained on the grass-covered portion of the survey, the use of GPR appears to have been justified.

00 2159

APPENDIX B

RESISTIVITY SOUNDING DATA

002160

RESISTIVITY SOUNDING SURVEY DATA

SOIL CONDITION : Very Damp

JOB NO. : 85-317

SOUNDING NO. : S-1

TABLE NO. : 1

DATE : 10-17-85

ELECTRODE PLACEMENT feet	ELECTRODE SPACING feet (A)	READING $2\pi V/I$ (R)	SCALE (S)	DIAL VALUE ohm D = R x S (D)	BARNES' METHOD $(A_2 - A_1)\frac{D_1 \times D_2}{D_1 - D_2} \times 30.5$ ohm-cm (E)	OHM-FEET D x A (F)	MOORE'S METHOD $\sum F$	REMARKS
1.5 - 4.5	3	491.0	.1	49.1	4492.7	147.3	147.3	
3 - 9	6	171.1	.1	17.11	2402.9	102.7	250.0	
4.5 - 13.5	9	845.0	.01	8.45	1527.6	79.1	329.1	
6 - 18	12	600.0	.01	6.003	1896.8	72.0	401.1	
7.5 - 22.5	15	498.2	.01	4.982	2680.2	74.7	475.8	
9 - 27	18	430.3	.01	4.303	2888.9	77.5	553.3	
10.5 - 39.5	21	356.7	.01	3.567	1908.2	74.9	628.2	

McBride-Ratcliff and Associates, Inc.

RESISTIVITY SOUNDING SURVEY DATA

SOIL CONDITION : Very Damp

JOB NO. : 85-317

SOUNDING NO. : S-1, Lee-Left

TABLE NO. : 2

DATE : 10-17-85

ELECTRODE PLACEMENT feet	ELECTRODE SPACING feet (A)	READING $2\pi V/I$ (R)	SCALE (S)	DIAL VALUE ohm D = R x S (D)	BARNES' METHOD $2(A_2 - A_1)\frac{D_1 \times D_2}{D_1 - D_2} \times 30.5$ ohm-cm (E)	OHM-FEET D x 2A (F)	MOORE'S METHOD ΣF	REMARKS
1.5 - 4.5	3	260.8	.1	26.08	4772.6	156.5	156.5	
3 - 9	6	105.7	.1	10.57	3252.5	126.8	283.3	
4.5 - 13.5	9	551.0	.01	5.51	2106.3	99.2	382.5	
6 - 18	12	356.1	.01	3.561	1842.3	85.3	468.0	
7.5 - 22.5	15	280.3	.01	2.803	1842.3	84.1	552.1	
9 - 27	18	218.8	.01	2.188	1824.4	78.8	630.9	
10.5 - 39.5	21	189.7	.01	1.897	2610.2	79.7	710.6	

McBride-Ratcliff and Associates, Inc.

RESISTIVITY SOUNDING SURVEY DATA

SOIL CONDITION : Very Damp **JOB NO. :** 85-317

SOUNDING NO. : S-1, Lee-Right **TABLE NO. :** 3 **DATE :** 10-17-85

ELECTRODE PLACEMENT feet	ELECTRODE SPACING feet (A)	READING $2\pi V/I$ (R)	SCALE (S)	DIAL VALUE ohm $D = R \times S$ (D)	BARNES' METHOD $2(A_2 - A_1)\frac{D_1 \times D_2}{D_1 - D_2} \times 30.5$ ohm-cm (E)	OHM-FEET $D \times 2A$ (F)	MOORE'S METHOD ΣF	REMARKS
1.5 - 4.5	3	233.1	.1	23.31	4265.7	139.9	139.9	
3 - 9	6	69.2	.1	6.92	1801.0	83.0	222.9	
4.5 - 13.5	9	288.2	.01	2.882	4903.8	51.9	274.8	
6 - 18	12	217.6	.01	2.476	3216.4	44.6	319.4	
7.5 - 22.5	15	245.0	.01	2.45	42696.7	73.5	352.9	
9 - 27	18	219.9	.01	2.99	3928.0	79.2	472.1	
10.5 - 39.5	21	183.0	.01	1.83	1995.7	76.9	549.0	

McBride-Ratcliff and Associates, Inc.

RESISTIVITY SOUNDING SURVEY DATA

SOIL CONDITION : Very Damp

JOB NO. : 85-317

SOUNDING NO. : S-2

TABLE NO. : 4

DATE : 10-17-85

ELECTRODE PLACEMENT feet	ELECTRODE SPACING feet (A)	READING $2\pi V/I$ (R)	SCALE (S)	DIAL VALUE ohm $D = R \times S$ (D)	BARNES' METHOD $(A_2 - A_1)\frac{D_1 \times D_2}{D_1 - D_2} \times 30.5$ ohm-cm (E)	OHM-FEET $D \times A$ (F)	MOORE'S METHOD ΣF	REMARKS
1.5 - 4.5	3	790.0	.1	49.0	4483.5	147.0	147.0	
3 - 9	6	159.0	.1	15.9	2153.7	95.4	242.4	
4.5 - 13.5	9	815.7	.01	8.157	1532.6	73.4	315.8	
6 - 18	12	542.5	.01	5.425	1482.1	65.1	380.9	
7.5 - 22.5	15	426.0	.01	4.26	1815.1	63.9	444.8	
9 - 27	18	326.4	.01	3.264	1277.4	58.8	503.6	
10.5 - 39.5	21	307.6	.01	3.07	4726.2	64.5	568.1	

McBride-Ratcliff and Associates, Inc.

RESISTIVITY SOUNDING SURVEY DATA

SOIL CONDITION : Very Damp

JOB NO. : 85-317

SOUNDING NO. : S-2, Lee-Left

TABLE NO. : 5

DATE : 10-17-85

ELECTRODE PLACEMENT feet	ELECTRODE SPACING feet (A)	READING $2\pi V/I$ (R)	SCALE (S)	DIAL VALUE ohm D = R x S (D)	BARNES' METHOD $2(A_2 - A_1)\frac{D_1 \times D_2}{D_1 - D_2} \times 30.5$ ohm-cm (E)	OHM-FEET D x 2A (F)	MOORE'S METHOD ΣF	REMARKS
1.5 - 4.5	3	140.3	.1	14.03	2567.5	84.2	84.2	
3 - 9	6	48.5	.1	4.85	1356.5	58.2	142.4	
4.5 - 13.5	9	344.3	.01	3.443	2171.9	62.0	204.4	
6 - 18	12	319.5	.01	3.145	8117.2	76.7	281.1	
7.5 - 22.5	15	242.5	.01	2.425	1841.4	72.8	353.9	
9 - 27	18	188.5	.01	1.885	1549.1	67.9	421.8	
10.5 - 39.5	21	153.6	.01	1.536	1518.2	64.5	486.3	

McBride-Ratcliff and Associates, Inc.

RESISTIVITY SOUNDING SURVEY DATA

SOIL CONDITION : Very Damp **JOB NO. :** 85-317

SOUNDING NO. : S-2, Lee-Right **TABLE NO. :** 6 **DATE :** 10-17-85

ELECTRODE PLACEMENT feet	ELECTRODE SPACING feet (A)	READING $2\pi V/I$ (R)	SCALE (S)	DIAL VALUE ohm D = R x S (D)	BARNES' METHOD $2(A_2 - A_1)\frac{D_1 \times D_2}{D_1 - D_2} \times 30.5$ ohm-cm (E)	OHM-FEET D x 2A (F)	MOORE'S METHOD ΣF	REMARKS
1.5 - 4.5	3	341.4	.1	34.14	6247.6	204.8	204.8	
3 - 9	6	117.0	.1	11.70	3252.5	140.4	345.2	
4.5 - 13.5	9	480.4	.01	4.804	1491.6	86.5	431.7	
6 - 18	12	243.4	.01	2.434	902.9	58.4	990.1	
7.5 - 22.5	15	201.5	.01	2.015	2142.1	60.5	550.6	
9 - 27	18	156.1	.01	2.561	1267.9	56.2	606.8	
10.5 - 39.5	21	223.8	.01	2.238		94.0	700.8	

McBride-Ratcliff and Associates, Inc.

RESISTIVITY SOUNDING SURVEY DATA

SOIL CONDITION : Wet

JOB NO. : 85-317

SOUNDING NO. : S-3

TABLE NO. : 7

DATE : 10-17-85

ELECTRODE PLACEMENT feet	ELECTRODE SPACING feet (A)	READING $2\pi V/I$ (R)	SCALE (S)	DIAL VALUE ohm $D = R \times S$ (D)	BARNES' METHOD $(A_2 - A_1)\frac{D_1 \times D_2}{D_1 - D_2} \times 30.5$ ohm-cm (E)	OHM-FEET $D \times A$ (F)	MOORE'S METHOD ΣF	REMARKS
1.5 - 4.5	3	250.1	.1	25.01	2288.4	75.0	75.0	
3 - 9	6	122.3	.1	12.23	2189.9	73.4	148.4	
4.5 - 13.5	9	107.1	.1	10.71	7884.9	96.4	244.8	
6 - 18	12	231.6	.01	2.316	349.6	33.8	278.6	
7.5 - 22.5	15	266.7	.01	2.667	4612.0	40.0	318.6	
9 - 27	18	168.8	.01	1.688	420.8	30.4	349.0	
10.5 - 39.5	21	155.9	.01	1.559	1866.6	32.7	381.7	

McBride-Ratcliff and Associates, Inc.

RESISTIVITY SOUNDING SURVEY DATA

SOIL CONDITION : Wet

JOB NO. : 85-317

SOUNDING NO. : S-3, Lee-Left

TABLE NO. : 8

DATE : 10-17-85

ELECTRODE PLACEMENT feet	ELECTRODE SPACING feet (A)	READING $2\pi V/I$ (R)	SCALE (S)	DIAL VALUE ohm $D = R \times S$ (D)	BARNES' METHOD $2(A_2 - A_1)\frac{D_1 \times D_2}{D_1 - D_2} \times 30.5$ ohm-cm (E)	OHM-FEET $D \times 2A$ (F)	MOORE'S METHOD ΣF	REMARKS
1.5 - 4.5	3	110.4	.1	11.04	2020.3	66.2	66.2	
3 - 9	6	63.3	.1	6.33	2715.2	75.0	142.2	
4.5 - 13.5	9	61.3	.1	6.13	35504.7	110.3	252.5	
6 - 18	12	306.6	.01	3.066	1122.5	72.6	326.1	
7.5 - 22.5	15	236.0	.01	2.360	1880.3	70.8	396.9	
9 - 27	18	181.1	.01	1.811	1424.7	65.2	462.1	
10.5 - 39.5	21	132.5	.01	1.325	903.5	55.7	517.8	

McBride-Ratcliff and Associates, Inc.

RESISTIVITY SOUNDING SURVEY DATA

SOIL CONDITION : Wet

JOB NO. : 85-317

SOUNDING NO. : S-3, Lee-Right

TABLE NO. : 9

DATE : 10-17-85

ELECTRODE PLACEMENT feet	ELECTRODE SPACING feet (A)	READING $2\pi V/I$ (R)	SCALE (S)	DIAL VALUE ohm $D = R \times S$ (D)	BARNES' METHOD $2(A_2 - A_1)\frac{D_1 \times D_2}{D_1 - D_2} \times 30.5$ ohm-cm (E)	OHM-FEET $D \times 2A$ (F)	MOORE'S METHOD $\sum F$	REMARKS
1.5 - 4.5	3	154.0	.1	15.4	2818.2	92.4	92.4	
3 - 9	6	75.3	.1	7.53	2696.5	90.4	182.8	
4.5 - 13.5	9	57.8	.1	5.78	4551.3	104.0	286.8	
6 - 18	12	31.0	.01	0.31	60.0	7.4	294.2	
7.5 - 22.5	15	96.8	.01	0.968		29.0	323.2	
9 - 27	18	90.5	.01	0.905	2544.6	32.6	355.8	
10.5 - 39.5	21	61.1	.01	0.611	344.2	25.7	381.5	

McBride-Ratcliff and Associates, Inc.

RESISTIVITY SOUNDING SURVEY DATA

SOIL CONDITION : Wet

JOB NO. : 85-317

SOUNDING NO. : S-4

TABLE NO. : 10

DATE : 10-17-85

ELECTRODE PLACEMENT feet	ELECTRODE SPACING feet (A)	READING $2\pi V/I$ (R)	SCALE (S)	DIAL VALUE ohm D = R x S (D)	BARNES' METHOD $(A_2 - A_1)\frac{D_1 \times D_2}{D_1 - D_2} \times 30.5$ ohm-cm (E)	OHM-FEET D x A (F)	MOORE'S METHOD ΣF	REMARKS
1.5 - 4.5	3	348.3	.1	34.85	3187.0	104.5	104.5	
3 - 9	6	110.6	.1	11.06	1482.9	66.4	170.9	
4.5 - 13.5	9	449.2	.01	4.492	692.1	40.4	211.3	
6 - 18	12	415.5	.01	4.155	5067.6	49.9	261.2	
7.5 - 22.5	15	372.6	.01	3.726	3302.0	55.9	312.1	
9 - 27	18	205.0	.01	2.05	417.0	36.9	354.0	
10.5 - 39.5	21	184.5	.01	1.845	1688.2	38.8	392.8	

McBride-Ratcliff and Associates, Inc.

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RESISTIVITY SOUNDING SURVEY DATA

SOIL CONDITION : Wet

JOB NO. : 85-317

SOUNDING NO. : S-4 Lee-Left

TABLE NO. : 11

DATE : 10-17-85

ELECTRODE PLACEMENT feet	ELECTRODE SPACING feet (A)	READING $2\pi V/I$ (R)	SCALE (S)	DIAL VALUE ohm $D = R \times S$ (D)	BARNES' METHOD $2(A_2 - A_1)\frac{D_1 \times D_2}{D_1 - D_2} \times 30.5$ ohm-cm (E)	OHM-FEET $D \times 2A$ (F)	MOORE'S METHOD ΣF	REMARKS
1.5 - 4.5	3	3213.8	.1	21.38	3912.5	128.3	128.3	
3 - 9	6	68.9	.1	6.89	1860.4	82.7	211.0	
4.5 - 13.5	9	373.9	.1	3.739	1496.2	67.3	278.3	
6 - 18	12	286.1	.01	2.861	2229.6	68.7	347.0	
7.5 - 22.5	15	260.5	.01	2.605	5327.7	39.1	386.1	
9 - 27	18	172.2	.01	1.722	929.7	62.0	448.1	
10.5 - 39.5	21	189.1	.01	1.891	-	79.4	527.5	

McBride-Ratcliff and Associates, Inc.

RESISTIVITY SOUNDING SURVEY DATA

SOIL CONDITION : Wet

JOB NO. : 85-317

SOUNDING NO. : S-4 Lee-Right

TABLE NO. : 12

DATE : 10-17-85

ELECTRODE PLACEMENT feet	ELECTRODE SPACING feet (A)	READING $2\pi V/I$ (R)	SCALE (S)	DIAL VALUE ohm $D = R \times S$ (D)	BARNES' METHOD $2(A_2 - A_1)\frac{D_1 \times D_2}{D_1 - D_2} \times 30.5$ ohm-cm (E)	OHM-FEET $D \times 2A$ (F)	MOORE'S METHOD ΣF	REMARKS
1.5 - 4.5	3	142.7	.1	14.27	2611.4	85.6	85.6	
3 - 9	6	52.3	.1	5.23	1510.8	62.8	148.4	
4.5 - 13.5	9	149.0	.01	1.49	381.3	26.8	175.2	
6 - 18	12	151.3	.01	1.513		36.3	211.5	
7.5 - 22.5	15	102.5	.01	1.025	581.6	30.8	242.3	
9 - 27	18	79.8	.01	0.798	659.4	28.7	271.0	
10.5 - 39.5	21	50.9	.01	0.509	257.2	21.4	292.4	

McBride-Ratcliff and Associates, Inc.

RESISTIVITY SOUNDING SURVEY DATA

SOIL CONDITION : Wet

JOB NO. : 85-317

SOUNDING NO. : S-5

TABLE NO. : 13

DATE : 10-17-85

ELECTRODE PLACEMENT feet	ELECTRODE SPACING feet (A)	READING $2\pi V/I$ (R)	SCALE (S)	DIAL VALUE ohm D = R x S (D)	BARNES' METHOD $(A_2 - A_1)\frac{D_1 \times D_2}{D_1 - D_2} \times 30.5$ ohm-cm (E)	OHM-FEET D x A (F)	MOORE'S METHOD ΣF	REMARKS
1.5 - 4.5	3	479.3	.1	47.93	4385.6	143.8	143.8	
3 - 9	6	172.2	.1	17.72	2459.1	103.3	247.1	
4.5 - 13.5	9	108.1	.1	10.81	2657.2	97.3	344.4	
6 - 18	12	746.3	.01	2.463	2205.5	89.6	434.0	
7.5 - 22.5	15	596.5	.01	5.965	4073.3	89.4	523.5	
9 - 27	18	438.6	.01	4.386	1516.1	157.9	681.4	
10.5 - 39.5	21	372.1	.01	3.721	1488.9	78.1	759.5	

McBride-Ratcliff and Associates, Inc.

RESISTIVITY SOUNDING SURVEY DATA

SOIL CONDITION : Wet

JOB NO. : 85-317

SOUNDING NO. : S-5, Lee-Left

TABLE NO. : 14

DATE : 10-17-85

ELECTRODE PLACEMENT feet	ELECTRODE SPACING feet (A)	READING $2\pi V/I$ (R)	SCALE (S)	DIAL VALUE ohm $D = R \times S$ (D)	BARNES' METHOD $2(A_2 - A_1)\frac{D_1 \times D_2}{D_1 - D_2} \times 30.5$ ohm-cm (E)	OHM-FEET $D \times 2A$ (F)	MOORE'S METHOD ΣF	REMARKS
1.5 - 4.5	3	277.5	.1	27.75	5078.3	166.5	166.5	
3 - 9	6	93.3	.1	9.33	2572.2	112.0	278.5	
4.5 - 13.5	9	111.9	.1	11.19		201.4	479.9	
6 - 18	12	453.0	.01	4.53	1392.8	108.72	588.6	
7.5 - 22.5	15	379.7	.01	3.797	4294.2	113.9	702.5	
9 - 27	18	259.4	.01	2.594	1498.3	93.4	795.9	
10.5 - 39.5	21	191.0	.01	1.91	1325.6	80.2	876.1	

RESISTIVITY SOUNDING SURVEY DATA

SOIL CONDITION : Wet

JOB NO. : 85-317

SOUNDING NO. : S-5, Lee-Right

TABLE NO. : 15

DATE : 10-17-85

ELECTRODE PLACEMENT feet	ELECTRODE SPACING feet (A)	READING $2\pi V/i$ (R)	SCALE (S)	DIAL VALUE ohm $D = R \times S$ (D)	BARNES' METHOD $2(A_2-A_1)\frac{D_1 \times D_2}{D_1 - D_2} \times 30.5$ ohm-cm (E)	OHM-FEET $D \times 2A$ (F)	MOORE'S METHOD ΣF	REMARKS
1.5 - 4.5	3	203.1	.1	20.31	3716.7	121.9	121.9	
3 - 9	6	84.7	.1	8.47	2658.8	101.6	223.5	
4.5 - 13.5	9	66.2	.1	6.62	5546.5	119.2	342.7	
6 - 18	12	300.5	.01	3.005	1007.0	72.1	414.8	
7.5 - 22.5	15	214.0	.01	2.14	1360.5	64.2	479.0	
9 - 27	18	186.0	.01	1.86	2601.5	67.0	546.0	
10.5 - 39.5	21	187.8	.01	1.878		78.9	624.9	

McBride-Ratcliff and Associates, Inc.

RESISTIVITY SOUNDING SURVEY DATA

SOIL CONDITION : Wet

JOB NO. : 85-317

SOUNDING NO. : S-6

TABLE NO. : 16

DATE : 10-17-85

ELECTRODE PLACEMENT feet	ELECTRODE SPACING feet (A)	READING $2\pi V/I$ (R)	SCALE (S)	DIAL VALUE ohm $D = R \times S$ (D)	BARNES' METHOD $(A_2 - A_1)\frac{D_1 \times D_2}{D_1 - D_2} \times 30.5$ ohm-cm (E)	OHM-FEET $D \times A$ (F)	MOORE'S METHOD $\sum F$	REMARKS
1.5 - 4.5	3	301.8	.1	30.18	2761.5	90.5	90.5	
3 - 9	6	120.3	.1	12.03	1830.3	72.2	162.7	
4.5 - 13.5	9	735.5	.01	7.355	1731.8	66.2	228.9	
6 - 18	12	573.7	.01	5.737	2022.5	68.8	297.7	
7.5 - 22.5	15	544.6	.01	5.446	9824.1	81.7	379.4	
9 - 27	18	402.9	.01	4.029	1416.9	72.5	451.9	
10.5 - 39.5	21	340.5	.01	3.405	2011.6	71.5	523.4	

McBride-Ratcliff and Associates, Inc.

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RESISTIVITY SOUNDING SURVEY DATA

SOIL CONDITION : Wet

JOB NO. : 85-317

SOUNDING NO. : S-6, Lee-Left

TABLE NO. : 17

DATE : 10-17-85

ELECTRODE PLACEMENT feet	ELECTRODE SPACING feet (A)	READING $2\pi V/I$ (R)	SCALE (S)	DIAL VALUE ohm $D = R \times S$ (D)	BARNES' METHOD $2(A_2 - A_1)\frac{D_1 \times D_2}{D_1 - D_2} \times 30.5$ ohm-cm (E)	OHM-FEET $D \times 2A$ (F)	MOORE'S METHOD $\sum F$	REMARKS
1.5 - 4.5	3	164.7	.1	16.47	3014.0	98.8	98.8	
3 - 9	6	70.8	.1	7.08	2272.5	85.0	183.8	
4.5 - 13.5	9	401.5	.01	4.015	1697.2	72.3	256.1	
6 - 18	12	305.7	.01	3.057	2344.6	73.4	329.5	
7.5 - 22.5	15	269.5	.01	2.695	4164.8	80.9	410.4	
9 - 27	18	215.6	.01	2.156	1972.7	77.6	488.0	
10.5 - 39.5	21	201.4	.01	2.014	5595.9	84.6	572.6	

McBride-Ratcliff and Associates, Inc.

RESISTIVITY SOUNDING SURVEY DATA

SOIL CONDITION : Wet **JOB NO. :** 85-317

SOUNDING NO. : S-6, Lee-Right **TABLE NO. :** 18 **DATE :** 10-17-85

ELECTRODE PLACEMENT feet	ELECTRODE SPACING feet (A)	READING $2\pi V/I$ (R)	SCALE (S)	DIAL VALUE ohm D = R x S (D)	BARNES' METHOD $2(A_2 - A_1)\frac{D_1 \times D_2}{D_1 - D_2} \times 30.5$ ohm-cm (E)	OHM-FEET D x 2A (F)	MOORE'S METHOD ΣF	REMARKS
1.5 - 4.5	3	157.2	.1	1572	2876.8	94.3	94.3	
3 - 9	6	73.7	.1	7.37	2539.1	88.4	182.7	
4.5 - 13.5	9	385.3	.01	3.853	1477.6	69.4	252.1	
6 - 18	12	294.1	.01	2.941	2273.8	70.6	322.7	
7.5 - 22.5	15	308.9	.01	3.089	-	92.7	415.4	
9 - 27	18	207.5	.01	2.025	1156.8	74.7	490.1	
10.5 - 39.5	21	171.6	.01	1.716	1815.0	72.1	562.2	

McBride-Ratcliff and Associates, Inc.

RESISTIVITY SOUNDING SURVEY DATA

SOIL CONDITION : Wet

SOUNDING NO. : S-7

TABLE NO. : 19

JOB NO. : 85-317

DATE : 10-17-85

ELECTRODE PLACEMENT feet	ELECTRODE SPACING feet (A)	READING $2\pi V/I$ (R)	SCALE (S)	DIAL VALUE ohm D = R x S (D)	BARNES' METHOD $(A_2 - A_1)\frac{D_1 \times D_2}{D_1 - D_2} \times 30.5$ ohm-cm (E)	OHM-FEET D x A (F)	MOORE'S METHOD ΣF	REMARKS
1.5 - 4.5	3	368.9	.1	36.89	3375.4	110.7	110.7	
3 - 9	6	150.5	.1	15.05	2326.0	90.3	201.0	
4.5 - 13.5	9	107.1	.1	10.71	3398.3	96.4	297.4	
6 - 18	12	102.0	.1	10.20	19,599.3	122.4	419.8	
7.5 - 22.5	15	652.0	.01	6.520	1653.6	97.8	517.6	
9 - 27	18	509.4	.01	5.094	2131.1	91.7	609.3	
10.5 - 39.5	21	399.7	.01	3.994	1692.4	83.9	693.2	

McBride-Ratcliff and Associates, Inc.

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RESISTIVITY SOUNDING SURVEY DATA

SOIL CONDITION : Wet

JOB NO. : 85-317

SOUNDING NO. : S-7, Lee-Left

TABLE NO. : 20

DATE : 10-17-85

ELECTRODE PLACEMENT feet	ELECTRODE SPACING feet (A)	READING $2\pi V/I$ (R)	SCALE (S)	DIAL VALUE ohm $D = R \times S$ (D)	BARNES' METHOD $2(A_2 - A_1)\frac{D_1 \times D_2}{D_1 - D_2} \times 30.5$ ohm-cm (E)	OHM-FEET $D \times 2A$ (F)	MOORE'S METHOD ΣF	REMARKS
1.5 - 4.5	3	191.6	.1	19.16	3506.3	115.0	115.0	
3 - 9	6	66.6	.1	6.66	1868.1	79.9	194.9	
4.5 - 13.5	9	61.7	.1	6.17	15,346.7	111.1	309.0	
6 - 18	12	51.9	.1	5.19	5979.7	124.6	433.6	
7.5 - 22.5	15	270.3	.01	2.703	1032.3	81.09	514.7	
9 - 27	18	221.3	.01	2.213	2234.0	79.7	594.7	
10.5 - 39.5	21	187.7	.01	1.877	2262.3	78.8	673.5	

McBride-Ratcliff and Associates, Inc.

002180

RESISTIVITY SOUNDING SURVEY DATA

SOIL CONDITION : Wet

JOB NO. : 85-317

SOUNDING NO. : S-7, Lee-Right

TABLE NO. : 21

DATE : 10-17-85

ELECTRODE PLACEMENT feet	ELECTRODE SPACING feet (A)	READING $2\pi V/I$ (R)	SCALE (S)	DIAL VALUE ohm $D = R \times S$ (D)	BARNES' METHOD $2(A_2 - A_1)\frac{D_1 \times D_2}{D_1 - D_2} \times 30.5$ ohm-cm (E)	OHM-FEET $D \times 2A$ (F)	MOORE'S METHOD ΣF	REMARKS
1.5 - 4.5	3	170.0	.1	17.0	3111.0	102.0	102.0	
3 - 9	6	92.8	.1	9.28	3739.6	111.4	213.4	
4.5 - 13.5	9	78.3	.1	7.83	9170.4	140.9	354.3	
6 - 18	12	59.0	.1	5.9	4380.3	141.6	495.9	
7.5 - 22.5	15	393.5	.01	3.935	2162.2	118.1	614.0	
9 - 27	18	292.9	.01	2.929	2096.6	105.4	719.4	
10.5 - 39.5	21	214.3	.01	2.143	1466.4	90.0	809.4	

McBride-Ratcliff and Associates, Inc.

RESISTIVITY SOUNDING SURVEY DATA

SOIL CONDITION : Wet

JOB NO. : 85-317

SOUNDING NO. : S-8

TABLE NO. : 22

DATE : 10-17-85

ELECTRODE PLACEMENT feet	ELECTRODE SPACING feet (A)	READING $2\pi V/I$ (R)	SCALE (S)	DIAL VALUE ohm $D = R \times S$ (D)	BARNES' METHOD $(A_2 - A_1)\frac{D_1 \times D_2}{D_1 - D_2} \times 30.5$ ohm-cm (E)	OHM-FEET $D \times A$ (F)	MOORE'S METHOD ΣF	REMARKS
1.5 - 4.5	3	812.3	.1	81.23	7432.5	243.9	243.9	
3 - 9	6	147.3	.1	14.73	1646.3	88.9	332.3	
4.5 - 13.5	9	908.5	.01	9.085	2169.1	81.8	414.1	
6 - 18	12	593.2	.01	5.932	1564.0	71.2	485.3	
7.5 - 22.5	15	468.5	.01	4.685	2039.2	70.38	555.5	
9 - 27	18	390.1	.01	3.901	2133.0	70.31	625.7	
10.5 - 39.5	21	354.5	.01	3.543	3554.4	74.55	700.2	

McBride-Ratcliff and Associates, Inc.

RESISTIVITY SOUNDING SURVEY DATA

SOIL CONDITION : Wet
JOB NO. : 85-317
SOUNDING NO. : S-8, Lee-Left
TABLE NO. : 23
DATE : 10-17-85

ELECTRODE PLACEMENT feet	ELECTRODE SPACING feet (A)	READING $2\pi V/I$ (R)	SCALE (S)	DIAL VALUE ohm $D = R \times S$ (D)	BARNES' METHOD $2(A_2 - A_1)\frac{D_1 \times D_2}{D_1 - D_2} \times 30.5$ ohm-cm (E)	OHM-FEET $D \times 2A$ (F)	MOORE'S METHOD ΣF	REMARKS
1.5 - 4.5	3	697.5	.1	67.95	-	407.7	407.7	
3 - 9	6	69.2	.1	6.92	-	83.0	490.7	
4.5 - 13.5	9	230.9	.01	2.309	-	41.6	532.3	
6 - 18	12	233.9	.01	2.339	-	56.1	588.4	
7.5 - 22.5	15	137.5	.01	1.375	-	41.3	629.7	
9 - 27	18	148.7	.01	1.487	-	53.5	683.2	
10.5 - 39.5	21	156.8	.01	1.568	-	65.9	749.1	

McBride-Ratcliff and Associates, Inc.

RESISTIVITY SOUNDING SURVEY DATA

SOIL CONDITION : Wet　　　　**JOB NO. :** 85.317

SOUNDING NO. : S-8, Lee-Right　　　　**TABLE NO. :** 24　　　　**DATE :** 10-17-85

ELECTRODE PLACEMENT feet	ELECTRODE SPACING feet (A)	READING $2\pi V/I$ (R)	SCALE (S)	DIAL VALUE ohm D = R x S (D)	BARNES' METHOD $2(A_2 - A_1)\frac{D_1 \times D_2}{D_1 - D_2} \times 30.5$ ohm-cm (E)	OHM-FEET D x 2A (F)	MOORE'S METHOD ΣF	REMARKS
1.5 - 4.5	3	317.0	.1	31.7	5801.1	190.2	190.2	
3 - 9	6	78.1	.1	7.81	1896.5	93.7	283.9	
4.5 - 13.5	9	684.7	.01	6.847	10,161.9	123.2	407.2	
6 - 18	12	354.1	.01	3.541	1342.1	85.0	492.2	
7.5 - 22.5	15	334.0	.01	3.340	10,767.8	100.2	592.4	
9 - 27	18	252.0	.01	2.52	1878.4	90.7	683.1	
10.5 - 39.5	21	215.1	.01	2.151	2688.2	90.3	773.4	

McBride-Ratcliff and Associates, Inc.

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RESISTIVITY SOUNDING SURVEY DATA

SOIL CONDITION : Wet

JOB NO. : 85-317

SOUNDING NO. : S-9

TABLE NO. : 25

DATE : 10-17-85

ELECTRODE PLACEMENT feet	ELECTRODE SPACING feet (A)	READING $2\pi V/I$ (R)	SCALE (S)	DIAL VALUE ohm $D = R \times S$ (D)	BARNES' METHOD $(A_2 - A_1)\frac{D_1 \times D_2}{D_1 - D_2} \times 30.5$ ohm-cm (E)	OHM-FEET $D \times A$ (F)	MOORE'S METHOD $\sum F$	REMARKS
1.5 - 4.5	3	333.3	.1	33.33	30[illegible]9.7	100.0	100.0	
3 - 9	6	243.8	.1	24.38	8307.4	146.3	246.3	
4.5 - 13.5	9	557.1	.01	55.71	660.7	50.1	296.4	
6 - 18	12	382.0	.01	3.82	1112.1	45.8	342.2	
7.5 - 22.5	15	380.5	.01	3.805	88664.1	57.1	399.3	
9 - 27	18	315.0	.01	3.15	1674.3	59.7	456.0	
10.5 - 39.5	21	296.9	.01	2.969	4727.8	62.3	518.4	

McBride-Ratcliff and Associates, Inc.

RESISTIVITY SOUNDING SURVEY DATA

SOIL CONDITION : Wet

JOB NO. : 85-317

SOUNDING NO. : S-9, Lee Left

TABLE NO. : 26

DATE : 10-17-85

ELECTRODE PLACEMENT feet	ELECTRODE SPACING feet (A)	READING $2\pi V/I$ (R)	SCALE (S)	DIAL VALUE ohm $D = R \times S$ (D)	BARNES' METHOD $2(A_2 - A_1)\frac{D_1 \times D_2}{D_1 - D_2} \times 30.5$ ohm-cm (E)	OHM-FEET $D \times 2A$ (F)	MOORE'S METHOD ΣF	REMARKS
1.5 - 4.5	3	170.1	.1	17.01	1556.4	102.1	101.1	
3 - 9	6	178.5	.1	17.85	33073.8	214.2	316.3	
4.5 - 13.5	9	381.1	.01	3.811	443.4	68.6	384.9	
6 - 18	12	257.2	.01	2.572	723.9	61.7	446.6	
7.5 - 22.5	15	231.0	.01	2.310	2074.9	69.3	1139.6	
9 - 27	18	204.4	.01	2.044	1624.2	73.6	1213.2	
10.5 - 39.5	21	162.9	.01	1.629	734.1	68.4	1281.6	

McBride-Ratcliff and Associates, Inc.

RESISTIVITY SOUNDING SURVEY DATA

SOIL CONDITION : Wet

SOUNDING NO. : S-9, Lee-Right

TABLE NO. : 27

JOB NO. : 85-317

DATE : 10-17-85

ELECTRODE PLACEMENT feet	ELECTRODE SPACING feet (A)	READING $2\pi V/I$ (R)	SCALE (S)	DIAL VALUE ohm $D = R \times S$ (D)	BARNES' METHOD $2(A_2 - A_1)\frac{D_1 \times D_2}{D_1 - D_2} \times 30.5$ ohm-cm (E)	OHM-FEET $D \times 2A$ (F)	MOORE'S METHOD ΣF	REMARKS
1.5 - 4.5	3	195.3	.1	19.53	1787.0	117.2	117.2	
3 - 9	6	92.3	.1	9.23	1601.7	120.8	228.0	
4.5 - 13.5	9	112.5	.1	2.233	269.8	40.2	268.2	
6 - 18	12	144.9	.01	1.449	377.0	34.8	303.0	
7.5 - 22.5	15	186.2	.01	1.661	1499.0	49.9	352.9	
9 - 27	18	133.0	.01	1.330	609.2	47.9	400.8	
10.5 - 39.5	21	157.7	.01	1.577	777.0	66.2	467.0	

McBride-Ratcliff and Associates, Inc.

APPENDIX C

ELECTROMAGNETIC PROFILING DATA

002188

CONDUCTIVITY PROFILE DATA

JOB NO. : 85-317

SOIL CONDITION : Wet

PROFILE : Test site 1

STATION INTERVAL : 30' TABLE NO. : 28 DATE : 10/17/85

STATION NUMBER N-S	READING mmho/m (R)	REMARKS	STATION NUMBER E-W	READING mmho/m (R)	REMARKS	AVG. VALUE
1	53		1	51		52
2	54		2	56		55
3	52		3	52		52
4	44		4	45		44.5
5	54		5	53		53.5
6	330		6	Next to fence		
7	360		7	" " "		
8	46		8	47		46.5
9	44		9	44		44
10	49		10	50		49.5
11	55		11	57		56
12	50		12	7.9		29
13	98		13	84		91
14	66		14	80		73
15	49		15	47		48
16	42		16	43		42.5
17	47		17	47		47
18	220		18	Next to fence		
19	260		19	Next to fence		
20	50		20	50		50
21	41		21	41		41
22	52		22	52		52
23	98		23	34		66
24	60		24	59		59.5
25	50		25	52		51
26	85		26	36		60.5
27	61		27	64		62.5
28	45		28	39		42
29	50		29	50		50
30	210		30	Next to fence		

McBride-Ratcliff and Associates, Inc.

002189

CONDUCTIVITY PROFILE DATA

SOIL CONDITION : Wet

JOB NO. : 85-317

STATION INTERVAL : 30'

PROFILE : Test site 1

TABLE NO. : 28 cont.

DATE : 10/17/85

STATION NUMBER N-S	READING mmho/m (R)	REMARKS	STATION NUMBER E-W	READING mmho/m (R)	REMARKS	AVG. VALUE
31	230		31	Fence		
32	50		32	50		50
33	46		33	47		46.5
34	128		34	125		126.5
35	87		35	86		86.5
36	46		36	46		46
37	46		37	46		46
38	61		38	60		60.5
39	Neg. off scale		39	Neg. off scale		
40	54		40	54		54
41	48		41	48		48
42	180		42	Fence		
43	175		43	Fence		
44	51		44	52		51.5
45	88		45	88		88
46	115		46	110		112.5
47	63		47	62		62.5
48	51		48	51		51

McBride-Ratcliff and Associates, Inc.

002190

CONDUCTIVITY PROFILE DATA

JOB NO. : 85-317

SOIL CONDITION : Asphalt Paving

PROFILE : Test site 2

STATION INTERVAL : 30' TABLE NO. : 29

DATE : 8-22-85

STATION NUMBER N-S	READING mmho/m (R)	REMARKS	STATION NUMBER E-W	READING mmho/m (R)	REMARKS	AVG. VALUE
1	52		1	54		53
2	57		2	57		57
3	175		3	110		
4	84		4	88		86
5	80		5	79		79.5
6	63		6	62		62.5
7	57		7	58		57.5
8	52		8	54		53
9	51		9	51		51
10	57		10	57		57
11	60		11	60		60
12	76		12	78		77

McBride-Ratcliff and Associates, Inc.

002191

002191

CONDUCTIVITY PROFILE DATA

JOB NO. : 85-317

SOIL CONDITION : Concrete Paving

PROFILE : Test site 3

STATION INTERVAL : 30   TABLE NO. : 30   DATE : 8-28-85

STATION NUMBER N-S	READING mmho/m (R)	REMARKS	STATION NUMBER E-W	READING mmho/m (R)	REMARKS	AVG. VALUE
1	Neg. def		1	Neg. def		
2	72B			" "		
3	510			" "		
4	Neg. def			Neg. def.		
5	" "			" "		
6	" "					

McBride-Ratcliff and Associates, Inc.

002192